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ASTRONOMY IN PITTSBURGH.

Editor's Note:—Under the above title, an editorial in "The Presbyterian Banner" of Pittsburgh, Pa., Sept. 5, 1912, give the following interesting account, written from a theologian's point of view, of the recent meeting of the Astronomical and Astrophysical Society of America and the Dedication of the New Allegheny Observatory.

The fourteenth meeting of the Astronomical and Astrophysical Society of America was held in this city last week from Tuesday to Friday, and in connection with the meeting the new Allegheny Observatory of the University of Pittsburgh was dedicated.

About sixty members attended the Astronomical and Astrophysical Society, of whom one-fifth were women, and many of them were distinguished in astronomical circles. The President of the Society is Professor Edward C. Pickering, Director of the Harvard Observatory, who is one of the most eminent astronomers of the world. Daily sessions were held either at the Observatory or at the Hotel Schenley, and many papers were read and discussed, most of them being illustrated by lantern slides. While many of the papers were technical, yet most of them were intelligible to laymen, and we attended several sessions and listened to these papers and discussion with interest and profit. Each paper presented the results of original work by the reader and added something to the sum of astronomical knowledge.

There were papers on such subjects as "Irregularities in Atmospheric Refraction," "New Eclipsing Variable Stars," "Variable Asteroids," "Radial Motion in Sun Spots," "The Attraction of Sun Spots for Prominences," "The Orbits of Forty-four Eclipsing Binaries," and so on through about fifty subjects. Miss Annie J. Cannon, of the Harvard Observatory, read a paper on "The Progress of the Revised Draper Catalogue," which she is conducting with that marvelous labor and patience which these astronomers know how to put into their work, and Miss Caroline E. Furness, of Vassar, read a paper

on "Observations of Variable Stars made at the Vassar College Observatory," which was another illustration of the same scientific virtues. Variable stars and binaries seemed to have a special attraction for the members of the society and they took great delight in penetrating into their secrets and exposing them to one another and to the world. Of course these papers dealt not only in technical terms and terrifying mathematical formulae, but also in big figures and cosmic spaces which are appalling and inconceivable. One of these astronomers, even a slim delicate looking lady, thought nothing of handling stars a hundred thousand times as large as the sun and a million times as far away and would tell tales about them more wonderful and fascinating than any romance.

The question will occur to some minds, "What is the use of all these delicate and difficult observations and abstruse calculations and daring speculations?" In pragmatic terms, "What is their cash value?" The astronomer never stops to ask such a question nor even thinks of it. He is intent only on knowledge, and no labor or patience or sacrifice is too great a price to pay for the least addition to its sum. This process of looking ever more intently through the heavens with ever more powerful lenses and more subtle instruments, prying with longer and more sensitive feelers into every crack and nook of the universe dropping deeper plummets into the infinite sea of the skies and fishing them with finer-meshed nets, is increasing bit by bit our knowledge of the world in which we live. The astronomer never knows when he will light upon some fact which will prove to be the key that unlocks some door of the universe and disclose new wonders. Such knowledge is not without its practical uses in daily business of life as the orbits of the sun and stars interweave themselves with our agriculture and commerce and affect the price of bread in the market. Yet this is the least part of the value of such knowledge. The heavens themselves are the greatest piece of majesty and glory that human eyes ever see and their study has been the grand education of the race. To be able to see something more than twinkling lights and meaningless motions, to be able to witness their majestic march and read their secrets of size and distance, composition and temperature, to be able to walk in imagination along their blazing pathway and see worlds in process of birth and growth and decay, to look into God's workshop and see worlds flying in a shower of sparks from the anvil of creation, to look up with appreciative eyes at the violet dome of

God's vast mosque, lit with millions of astral lamps,—this adds immeasurably to the dignity and worth and noble joy of life, this crowns the spirit of man with glory and honor and shows him to be but little lower than divinity.

The dedication of the Allegheny Observatory of the University of Pittsburgh took place on Wednesday afternoon in the Observatory. This noble building has been about ten years in process of erection and has cost three hundred thousand dollars, all of which has been paid, with a comfortable balance left as the beginning of an endowment. It has three domes, in one of which is the old 13-inch telescope which has done much famous work; in another is Keeler's telescope, which has also rendered original service of the highest worth; but the chief possession and glory of the Observatory is the great 30-inch refractor in the main dome, which stands complete except for the 30-inch lens. The great difficulty of casting such a large block of glass without flaw has delayed the completion of the telescope longer than was expected, but it is hoped that another year will put this great eye in place so that it can look with unblinking gaze at the face of the sun and into the depths of space. The Observatory is equipped with an outfit of the most modern and perfect instruments and will be one of the great observatories of the world. Its telescope is exceeded by only two others in the world, the 36-inch refractor at the Lick Observatory in California and the 40-inch refractor at the Yerkes Observatory in Wisconsin.

The dedication ceremonies were held on the movable floor of the great dome, which was secured fast for the occasion, and the great tube of the telescope swung above the distinguished audience. Mr. William Lucien Scaife represented the Board of Trustees of the University and introduced the speakers. The exercises were opened with prayer by Professor Matthew Brown Riddle D. D., of the Western Theological Seminary, who offered the following appropriate prayer:

O Lord, our Lord, How excellent is thy name in all the earth! When we consider the heavens, the work of Thy hands, the moon and the stars which Thou hast made, Lord, what is man that Thou art mindful of him, and the son of man that Thou hast visited him? We thank Thee that Thou hast visited him in the person of Thy Son, and hast promised him dominion over the work of Thy hands. We are gathered to dedicate a building designed to help forward this promised dominion.

We therefore ask thy blessing upon it. We thank Thee that Thou didst open the hearts of our friends whose liberality erected it. Grant a blessing upon all here assembled and may the work done in this edifice be such as shall contribute, not only to human knowledge, but to the coming of the time when our blessed Lord shall be recognized as the Ruler of Nature as well as the Redeemer of men. Amen.

Dr. John A. Brashear then presented the Observatory to the trustees of the University. Dr. Brashear gave a series of interesting and delightful reminiscences of his connection with the Observatory from the time half a century ago, when as a workman in the iron mills on the south side of the city he used to climb the river hill and looking over to the dome of the old Observatory wish the day might come when he could go to it and look through its telescope. He traced the path he trod through his little work shop where he made his own telescope up to the day of this dedication in which his wildest dreams were surpassed. He gave reminiscences of his fellow laborers, paid tributes to the memory of William Thaw and others whose beneficence had made this realization possible and actual, and closed with a beautiful and touching reference to his wife, who had been his companion in the study of the stars.

Chancellor Samuel Black McCormick then received the Observatory in behalf of the University and delivered an eloquent address, in which he set forth its object, first, as a means of scientific research for extending the frontiers of human knowledge, and, second, as a means of popular instruction and entertainment, for this Observatory has a special instrument for the use of the public and its doors are open to the people, more than five thousand of whom have already passed through them and seen through its instrument the wonders of the sky. Frank Schlesinger, director of the Observatory, then explained its aim, and Professor Edward C. Pickering delivered an address on the work of the Observatory in the past and paid a high tribute to the ability and achievements and promises of its present Director. Just before delivering his address the distinguished Director of the Harvard Observatory had conferred on him the honorary degree of Doctor of Humane Letters (L.H.D.) by Chancellor McCormick, representing the trustees of the University of Pittsburgh.

The dedication exercises were followed by the unveiling of the memorial tablet on the great telescope to the memory of William Thaw and his son, William Thaw, Junior. After a

PLATE XXV.

SOUTH

1. The Red Spot
1912 July 11, 14^{h} 50^{m} G. M. T.

2. The South Tropical Disturbances
1912 June 20, 14^{h} 46^{m} G. M. T.

JUPITER, 1912

Drawn by Mr. Latimer J. Wilson, Nashville, Tenn.

brief address by Dr. Brashear, Mrs. Mary Thaw Thompson, daughter of William Thaw, removed the veil and disclosed a bronze tablet bearing the following inscription:

To Push Forward the Frontier of Human Knowledge, This Telescope is Erected, 1912, in Memory of William Thaw, and His Son, William Thaw, Junior, Life-long Students Deeply Interested in the Researches of Samuel Pierpont Langley and James Edward Keeler, Former Directors of This Observatory, Sharing Their Hopes and Making Possible Their Discoveries.

Mrs. Thompson recited the inscription and added a few appropriate words, in which she said that the individual withers in the presence of the stars and contrasting astronomy with the older sister astrology gave a free modern paraphrase from the Hebrew Psalm, The Heavens declare the glory of God and the firmament showeth his handiwork.

The whole service of dedication was in the finest taste and was deeply impressive, and at its conclusion the assembled audience was shown through the building and inspected some of its wonderful instruments. Thus was dedicated one of the great observatories of the world, which now stands on one of our hilltops as a magnificent and beautiful Temple of the Skies. It has already added to the fame to this city in the persons of its distinguished directors and in its celebrated achievements, and it will continue to be one of its noblest institutions and its lines will go out to the ends of the earth.

JUPITER, 1912.

LATIMER J. WILSON.

Though not in its best position for observers in the northern hemisphere Jupiter, when near the meridian, is fairly well seen from Nashville. Cloudy weather has greatly interfered with the systematic work desired but in the forty nights since April 3rd, when observations were possible, 144 recorded observations have been made.

The brilliant loop which distinguishes the preceding part of the great disturbance in the southern tropics, known as the South Tropical Dark Area, is moving forward in decreasing longitude at a rate more rapid than the following parts of the disturbance. Its motion is irregular, the mean for the past year being 0.3 of a degree per day. The following part of the

dark area terminates in a brilliant loop almost exactly like the preceding one, but reversed. The mean motion of this part of the marking for the past year has been about 0.27 of a degree per day, the whole length of the disturbance being at present about sixty-six degrees. Much interesting detail is seen in the region. The longitude of the center of the Red Spot as obtained from an observation of July 11th, 1912 is 308°, while that of the white notch in the S. component of the south equatorial belt is 302°. This is unchanged since May 31st. The Red Spot is bordered on the north by an intensely white strip. Several faint streaks were seen in the spot.

What seems to be the fragment of an obscured belt is almost a conspicuous feature of the northern hemisphere. Its longitude on May 31st was 47° and on July 11th it was 42°. The spot is elongated and is connected with the belts north and south by faint streaks. It is in about 20° north latitude, and is shown on the second drawing.

1405 Gartland Ave.,
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THE DISCOVERY OF THE PLANET NEPTUNE.

DAVID RINES.

I. The Puzzling Motion of Uranus.

The annals of astronomy can boast of few events so wrought with dramatic character as the discovery of Neptune. The discovery of a celestial body is in itself a matter of no rare occurence; but Neptune did not follow the common-place, prosaic methods of straying into the field of view of the telescope, or of unwittingly leaving a tell-tale impression upon the photographic plate. One of the foremost mathematical astronomers of his time, after a train of brilliant analysis and laborious calculation extending over a period of more than a year, directed the attention of astronomers many miles away to a region of the sky where, he asserted, would be found a new planet. Toward that region of the sky was pointed a telescope, and there, true enough, hung an additional member of the solar system. To intensify the situation, hardly had the world recovered from her thrill of astonishment, when the honors lavished upon the won-

derful man who had thus discovered a planet without so much as placing an eye to the telescope were suddenly laid claim to in behalf of a youth until then unknown. To make the episode still more extraordinary, men of science had just begun to regain their composure when they were again startled by the leading mathematician of the western hemisphere darting forward boldly to challenge the claims of both men. The scientific world became bewildered.

The planet Uranus was the cause of the turmoil. Discovered in 1781 by Sir William Herschel, it became at once the object of much attention, solicitude and care on the part of astronomers. Telescopes were turned upon it nightly, its physical appearance was carefully watched, and its motion and position from night to night carefully recorded.

Within a few months of the planet's discovery, attempts were made to reach a rough determination of its orbit. This, for the time being, was assumed to be circular. As the path of a planet, however, although nearly a circle, is really an ellipse, the computations served merely as temporary approximations, awaiting the accumulation of a sufficient number of observations for the computation of the true orbit. The next two years brought forth from various quarters fairly accurate elliptic elements.

Buoyed up by the hope that the planet, before discovery by Herschel, might have been observed as a fixed star, astronomers searched through the records of their predecessors, and were delighted to find their labors rewarded with the discovery of some twenty odd observations by Flamsteed, Mayer, Bradley and Lemonnier, extending over the period from 1690 to 1771.

Nine years elapsed, and observations were accumulating. The Academy of Sciences of Paris, deeming the data by this time sufficient in character and number for a fairly good determination of an orbit, proposed the theory of the planet's motion as the subject for a prize. Delambre carried off the prize as reward for a skillful mathematical treatment by which he deduced the elements of the planet's orbit and, with the help of these data, constructed tables for the planet's motion.

The utility of Delambre's work, however, was short-lived. The planet, though for a few years it faithfully conformed to the tables, soon disregarded the vast labors which Delambre had expended upon the computation of its orbit, and began to pursue a course totally different. In view of the fact that

the tables were, after all, a crude attempt, because based upon comparatively few observations and uncertain data, their failure to predict accurately the motion of the planet did not cause surprise.

The computation of an orbit, it must be remembered, is quite complex. In accordance with the universal Law of Gravitation, a planet is influenced not only by the sun, but also by the other planets; and it is pulled by these planets considerably away from the theoretical ellipse determined by the action of the sun alone. The deviations,—known technically as "perturbations,"—thus introduced into the planet's path enormously complicate a problem otherwise comparatively simple; for not only is there necessary a knowledge of the sun's action, but also of the perturbations introduced by every planet large enough and close enough to exert appreciable influence.

As time went on, and observations continued to accumulate, and more nearly perfect information was obtained of the perturbing planets, and better theory was established, men of science began to feel that the time had arrived for a new discussion of the motion of Uranus. In the second decade of the nineteenth century, accordingly, Alexis Bouvard attempted to construct a new set of tables.

He was much troubled over his inability to reconcile the ancient observations,—that is, those made of the planet before the discovery of its planetary nature,—with those of more recent date. The ancient observations, he found, could perfectly well be represented by points on an ellipse; so too, could the observations of more recent date; but, strange to say, the two ellipses were not identical. Despairing finally of reconciling the two sets of observations, Bouvard, reluctantly contenting himself with the explanation that the older observations were less precise and therefore untrustworthy, based his tables exclusively on the newer data.

For a few years the planet revolved in the orbit determined for it by the new tables. Soon, however, it began, as on the previous occasion, to assert its independence. Before very long, therefore, Bouvard's Tables became as unreliable as those of Delambre.

The inexplicable wanderings of the planet, combined with Bouvard's unsuccessful attempt to reconcile the old with the new observations, could not fail to produce a profound impression upon the minds of astronomers. The accuracy of

the computations was now almost certain. The trouble was not with the tables, but with the planet.

One more attempt was made to harmonize the theoretical with the actual motion of Uranus, but with no better result. A quarter of a century after the completion of Bouvard's Tables, his nephew Eugene, upon undertaking a similar task, found as much difficulty in reconciling the new observations which had by this time accumulated, with those of his uncle's time, as the uncle himself had experienced when attempting to harmonize the observations of his day with those of Flamsteed's.

This last laborious but unsuccessful attempt to account for the motion of Uranus created dismay. LeVerrier, at the suggestion of his friend, Arago, the astronomical chief of France, dropped for the time his researches on comets, to undertake the solution of the mystery.

II. An Undiscovered Planet.

No one could have been found better qualified to undertake this task than Urbain Jean Joseph LeVerrier. The high order of analysis displayed in his mathematical astronomical researches bore witness to his worth as a practical mathematician, and as a skilled computer he stood unexcelled. Though but thirty-one years of age, he had already attained a place among the foremost of contemporary mathematical astronomers.

To assure himself that the deviations of Uranus from its computed path were not merely apparent, but actual, LeVerrier determined first on a thorough investigation into the accuracy of Bouvard's Tables. He consequently revised the theory and, after his own fashion, checked the computations. These lengthy preliminary labors served a purpose in that they allayed the suspicions of astronomers that the mystery of Uranus lay concealed in imperfections of Bouvard's Tables. They proved instead that the theory was at fault. But one conclusion was possible. Uranus moved in an orbit different from that determined for it by the sun and the known planets.

Arrived now at the stage where he was compelled to bring to his aid the hypothesis of an unknown force acting upon the wandering planet, LeVerrier began examining in detail the speculations of men of science regarding the nature of this force. One suggestion was that the Law of Gravitation, as enunciated by Newton, was not quite accurate; and that at a distance from the sun as great as that of Uranus, the consequent error introduced on the assumption that Newton's Law held good

might become appreciable. A second hypothesis for the failure of the tables was that in their construction no account had been taken of the retarding influence of a rare ether, which those who held this view conceived to be diffused throughout space. Another conjecture was that Uranus had possibly been dragged out of its orbit by the perturbative effect of, or collision with, a passing comet; and still another explanation was that the planet was perhaps influenced by a large undiscovered satellite. Not a few astronomers hinted that Uranus was swerved from its computed path by the disturbing action of an unknown planet. Of the various hypotheses thus tentatively put forward, that of an unknown planet seemed to LeVerrier to be the most plausible; and he accordingly set himself the task of determining where in the heavens this planet might be found.

The task was not easy. The problem before him, known as the inverse problem of perturbations, was new; and though it can not be said to rank among the most difficult ever proposed, it was sufficiently difficult to require the skill of a master.

It is not our purpose here to delve into mathematical intricacies; yet, in order to make the sequel more intelligible, we should not omit to mention one of the obstacles presented by the problem. The problem seemed impossible of solution without a previous knowledge of the distance from the sun of the unknown planet. In the absence of this knowledge it was necessary to guess a value for this distance. Should the guess, in the course of the solution, prove too large or too small, it would serve to suggest an improved value with which to solve the problem anew. An intelligent guess, therefore, would result in considerable saving of labor.

It had long before been discovered that the distances of the known planets harmonized with an empirical formula known as Bode's Law. It seemed reasonable to suppose that the unknown planet, too, would follow this law. If so, then the planet should be twice as far removed from the sun as Uranus. LeVerrier consequently decided, as a first approximation, upon a value for the unknown distance twice that of Uranus.

Many were the difficulties to be overcome, many the obstacles to be surmounted, many the pitfalls to be avoided. At one stage of the solution, LeVerrier became so discouraged that he did not advance a step in his researches for three whole months. Eventually, however, he solved the problem. The mystery of

Uranus seemed at last explained. Its movements could be accounted for by the perturbations of a theoretical planet.

It is customary with investigators, in order that they may establish their title to priority, to publish news of their researches, either through the medium of the scientific journals, or by addresses before scientific societies. In accordance with this custom, LeVerrier on three different occasions reported his progress before the French Academy of Sciences. On November 10, 1845, he presented that body with an account of his preliminary labors. On June 1, 1846, he announced the results of a first approximation. And now, on August 31, he presented the final results. On this occasion, he pressed upon astronomers the task of seeking for the planet with their telescopes. The further to encourage them, he declared that the object of their search could easily be distinguished, in a good instrument, from neighboring stars of the eighth or ninth magnitude, by the fact that, like other planets, it possessed a sensible disk.

It is regrettable to record the exceedingly slight interest aroused in men of science by researches so extraordinary. For one reason or another, whether because of the enormous difficulties entailed in the task, the lack of necessary appliances, or their incredulity, astronomers were backward in undertaking the search. LeVerrier became almost frantic in his appeals. At length his exhortations fell upon willing ears. In acknowledging the receipt of a scientific paper from Dr. J. G. Galle of the Berlin Observatory, he seized the opportunity to urge that the Berlin astronomers employ their telescope in a search for the planet. Galle, nothing loth, immediately set about looking for a chart of the heavens to aid him in the work.

Twenty years previously there had been inaugurated the construction of a series of star maps detailing specified portions of the heavens. The map of that region containing the position of LeVerrier's planet had been completed by Dr. Bremiker late in the year 1845, but it had not yet been distributed. Astronomers consequently were unaware of its existence. At the suggestion of a young student, d'Arrest,—the famous astronomer of later years,—Galle sought for and obtained possession of the map. On the evening of September 23, 1846, the very day on which he received LeVerrier's letter, he seated himself at the telescope, and called out the configurations of the stars in the field of view, as d'Arrest checked them off on the map. Close to the planet's theoretical position the observer found a star

of the eighth magnitude which the assistant could not find depicted on the chart. Joy reigned! The object proved to be the planet.

The enthusiasm which seized upon scientific men, following the announcement that the planet had been actually detected with the telescope, stands out in marked contrast to the indifference and lack of interest which had prevailed previously. The whole world thrilled with wonder and amazement. Astronomers became lost in a frenzy of admiration and delight, and eagerly hastened to turn their telescopes upon the newly discovered inhabitant of the heavens. Not scientists alone, but men of all classes joined in paying tribute to the genius of LeVerrier. Everywhere the discovery was termed the most brilliant in the annals of astronomy, and it was rated the crowning achievement of the human intellect.

Suddenly, from across the English Channel came strange tidings. To the honor of discovery had appeared a rival claimant.

III. John Couch Adams.

John Couch Adams displayed while quite young a strong love for mathematics and astronomy. At ten years of age he had begun the study of algebra, as a boy he found pleasure in reading astronomical and mathematical works, and in his youth he derived untold delight from watching the heavenly bodies, computing their motions, and recording their positions with instruments of his own device. Though born of humble parents, his talents obtained early recognition, and it was accordingly decided to send him to college. Entering St. Johns College, Cambridge, at the age of twenty, he assumed at the start, and maintained to the end, the highest rank in his studies, graduating as first Smith's Prizeman and Senior Wrangler.

It was during the second year of his undergraduate career that chance directed to his hands a copy of Airy's report to the British Association on the progress of astronomy during the early years of the nineteenth century. In this report was mentioned the puzzling motion of Uranus, but without the least attempt to suggest an explanation. Deeply impressed, the young student seized in a flash of genius upon the true cause of the phenomenon, and fearful lest other matters should drive the subject from his mind, he was inspired to record the following memorandum:

"1841, July 3. Formed a design, in the beginning of this week, of investigating, as soon as possible after taking my degree, the irregularities in the motion of Uranus, which are yet unaccounted for; in order to find whether they may be attributed to the action of an undiscovered planet beyond it; and if possible thence to determine the elements of its orbit, etc., approximately, which would probably lead to its discovery."

Graduating in 1843, at the age of twenty four, and finding himself at last with sufficient leisure to warrant his taking up the problem, he put his ideas into execution by attempting a rough test computation based upon the assumption that the orbits both of Uranus and of the supposed disturbing body were circular. For the radius of the unknown orbit he decided to adopt a value, in accordance with Bode's Law, double that of Uranus, and for the data to rely exclusively upon the modern observations. Encouraged by the results of the rough solution, he attempted a closer approximation; then, convinced by these two preliminary attempts that his hypothesis was based upon fact, he determined upon a more accurate solution.

This third solution he based on better data received from the Astronomer Royal, Sir George Biddle Airy, through the agency of their common friend, Professor Challis, of the Cambridge Observatory. Though this solution proved unsatisfactory, it served to suggest slight improvements in method. Adams accordingly proceeded to a fourth, and this time was quite successful.

In September 1845, more than a month preceding LeVerrier's paper of November 10, and fully seven months earlier than that investigator's announcement, on June 1, 1846, of the results obtained by his first approximation, Adams placed in the hands of Professor Challis the elements of a theoretical planet, the perturbations by which, he claimed, would satisfactorily account for the motion of Uranus.

Possessed of but little initiative, Professor Challis, upon receiving the solution, found himself unable to decide upon a course of action befitting the occasion. He made no telescopic search of the heavens. It was "so novel a thing," in his own words, "to undertake observations in reliance upon merely theoretical deductions; and while much labor was certain, success appeared very doubtful". It was at length decided to lay the matter before the Astronomer Royal, and Adams was accordingly provided with a letter of introduction.

Hoping that such a procedure might lead to instituting a search for the planet, Adams presented himself at the Royal Observatory, Greenwich, but learned that the head of the institution had some time previovsly departed for the Continent. He was invited to communicate with Airy by letter. Preferring a personal interview, however, he called again a month later; and finding Airy temporarily absent, he left his card with the statement that he would soon return. Upon his return he was informed simply that the astronomer was at dinner. Disappointed at the outcome of his visits, he left a paper containing the results of a fifth solution, and departed.

Airy had repeatedly dampened the enthusiasm of eager astronomers by his skepticism regarding the existence of an undiscovered planet. This skepticism was still unshaken. Further, Airy had discovered, in the thirties, that the motion of Uranus was faulty not only in longitude, but also in the matter of its distance from the sun. He now seized upon this fact to test the value of Adams's work. In replying to Adams, fifteen days after the latter's visit, he accordingly inquired whether the hypothetical planet, besides accounting for the motion of Uranus in longitude, would also cause to disappear the errors in distance.

To Adams the question appeared extremely trivial and evasive. He had hoped for greater encouragement. Already deeply hurt by his reception at the Royal Observatory,—for he was of a highly sensitive nature,—he found difficulty in replying to the Astronomer Royal, and in the several attempts he made he failed to persevere. Meanwhile, believing that he could obtain a slightly more satisfactory solution, he started to solve the problem for the sixth time, and finally decided to postpone replying to Airy's letter until he could present the new results.

As for Airy, paying Adams no further attention pending the receipt of a reply to his letter, he took no steps either to commence a search for the planet, or to publish the results of Adams's calculations. This proved most unfortunate; for allowing LeVerrier time to step into the breach, it deprived Adams of claims to priority.

The publication of LeVerrier's paper of June 1 awoke Airy from his lethargy. Finding that the longitude of the theoretical body, as determined by LeVerrier, differed but little from that which Adams had communicated to him the previous October, he began to reflect whether, after all, there might not be some plausibility in the hypothesis of a disturbing planet.

The fact that two investigators, working independently, and unknown to each other, could arrive at the same result, strengthened immeasurably the probability that both were right. He soon changed from a doubting skeptic, carrying words of discouragement, into a zealous believer intent upon converting others.

His enthusiasm aroused like emotions in Challis, and between them they began to devise plans for a search of the heavens. Challis was to drop all work not of an urgent nature, and undertake to map carefully all stars as small as the eleventh magnitude included within a large region of the heavens having for its center the theoretical position of the planet. The plan called for three different sweeps of the region. If a star found in the first sweep were missing from its place in the second, it would be inferred that the object was the planet, and in case of doubt, reference could be made to the third sweep.

It may be wondered why a search on so elaborate a scale should have been thought necessary. It was not expected that the body could be easily distinguished from neighboring stars of equal magnitude. The only recourse, consequently, was to distinguish the stranger by its motion among the fixed stars. With the appliances of our day, the planet could much more easily have been found with the aid of photography. In the absence of this aid the next most ready method was to compare the heavens with previously published charts, for the purpose of ascertaining whether there were a star visible in the telescope which was missing from the charts. This was the method employed later with such good effect by Galle. Unfortunately, however, the English astronomers, in common with astronomers of other countries, not only did not have in their possession a copy of Bremiker's Map, but they were even unaware of its existence. The only course open was to prepare a map of their own by observation from night to night, and the method they adopted for this, though elaborate, offered this advantage,—that if it failed to disclose the planet, it would at least lead to the definite decision that no moving body so bright as the eleventh magnitude was to be found in the broad region of the heavens under consideration.

So immense was the task that Challis doubted whether he could complete it within a year, but nothing daunted, he set to work.

On September 29, 1846 he received a copy of LeVerrier's paper of August 31, and became much impressed with the French

geometer's confidence that the undiscovered planet could be readily distinguished from neighboring stars through the fact that it possessed an appreciable disk. Adams had long before this concluded from his calculations that the brightness of the planet was at least as great as that of a star of the ninth magnitude, and had suggested that it might be picked up in the telescope by its physical aspect. Challis had preferred, however, from considerations of thoroughness, to follow the plan of observation originally adopted. Finding now Adams's belief corroborated from another source, he decided to act upon it. Directing the telescope that very night to the immediate neighborhood of the planet's theoretical position, he began scrutinizing in detail the larger stars. One out of some three hundred of these attracted his attention through the fact that it appeared to have a disk. It was the planet.

Alas for Challis's hopes! He was too late to claim the honor of discovery. The planet has been observed six days previously at Berlin.

The news of Galle's good fortune put an end to the work at Cambridge. By that time, Challis had observed some three thousand stars, and was just getting ready to commence mapping. Going back over his notes, he found matter for deep vexation. Within the first four nights of observing he had recorded two positions of the planet, and had obtained sufficient data to assure its discovery. Had he but looked over the records of his observations from night to night,—labor postponed for more urgent work on comet reductions,—he might have obtained for himself the glory now Galle's. Fate was unkind. With success all but assured, the faithful astronomer had failed.

If fate was unkind to Challis, how much more so was it to Adams! He was the first to solve the problem of Uranus, he was the first to make known the existence of the new planet, yet his researches had exerted not the least influence upon the actual discovery. and at the time of discovery, his name even was unknown.

For this state of affairs he was in no way to blame. He had solved his problem, and communicated his results to two of the foremost astronomers of Europe, one of them the official head of astronomy in England. Receiving but little encouragement, he had made no further effort to spread the news of his calculations, or to urge astronomers that they search for his planet. He had even intended, if no one else would do so, to undertake the search himself; and with this end in view, had actually had

overhauled the instruments at St. John's College. Young, shy and sensitive, of a retiring and bashful disposition, unacquainted with the ways of the world, he had done his best. More could not have been expected.

The fault undoubtedly lay with the astronomers in whom he had confided. For almost a full year they had had in their possession data sufficient to assure discovery of the planet, and had failed until too late to act. Through their negligence, they had both deprived themselves of rewards now claimed by foreign astronomers, and had allowed a foreign mathematician to snatch from a young countryman the right to claim priority.

For these sins they received severe punishment at the hands of public opinion in England. It cannot be said, nevertheless, that they had wilfully neglected their duty. They were busy men. As Astronomer Royal, Airy had work sufficient on his hands. Challis, as director of the Cambridge Observatory, was actively engaged in furthering extensive researches on comets and asteroids. To start a systematic search for a theoretical planet meant to drop for an indefinite period other important work, and for months to devote endless labor and expense to a task regarding the successful outcome of which they were skeptical. It is to be noted, too, that once the probability of success became strengthened through the publication of LeVerrier's independent labors, they no longer hesitated.

The announcement of Adams's name as entitled to rank with that of LeVerrier in the story of the new planet awoke in France hostile and bitter criticism. And it must be admitted that there was just ground for complaint. The planet had been discovered entirely as a result of LeVerrier's researches, and in obedience to his earnest exhortations that the telescope be turned towards that portion of the heavens indicated by his theory. Previous to the discovery no mention had been made of Adams. The appearance now of a rival claimant to LeVerrier's honors seemed a dastardly attempt on the part of English astronomers to step beyond the fair limits of national rivalry for the purpose of robbing the French of their due.

English astronomers, strange as it may seem, were many of them no less opposed to Adams's claims than the French. If the latter were guided in their criticisms by a sense of injustice, the former were swayed by a warped feeling of national fairness. However mortified that the honors should have gone to a foreigner, they refused—and with some show of justice per-

haps—to look upon Adams's communications to Challis and Airy as a publication, and conceded to LeVerrier the honor of being the sole theoretical discoverer of the planet.

Foreign astronomers on both sides of the Atlantic took a fairer view of the situation. Though recognizing that LeVerrier had established his title to priority through previous publication, they did not lose sight of the fact that Adams had in reality preceded LeVerrier in the theoretical discovery. They realized, too, that the fault was less Adams's than that of Airy and Challis. Their verdict has been upheld by later astronomers, but only after the lapse of years.

Adams himself took no part in the controversy. Not a word of criticism ever passed his lips; not an accusation did he ever make; not a man did he ever blame. Personally, he made no efforts in his own behalf. On the contrary, he awarded to LeVerrier "his just claims to the honor of discovery."

Upon the fortunate Frenchman the world heaped countless honors. From all directions came words of congratulation and praise. Scientific academies all over Europe and America vied with one another in hastening to elect him one of themselves. Prizes and medals came to him unsolicited. Kings paid him homage. It was even proposed that the planet bear his name. And Galle, too, received a share of the honors. Adams alone was neglected.

IV. Later Developments.

The accumulation of observations brought to light a startling fact. The observations failed to conform to the tables furnished by the theory of Adams and LeVerrier! It was accordingly attempted to compute an orbit entirely independent of the theory, and based upon the observations only. The result was even more startling. The orbit, far from being quite elliptical, as predicted, was very nearly a circle, and with a radius much smaller than that indicated by theory.

Here indeed was a mystery. Relying upon predictions based upon calculations, astronomers had discovered a planet, only to find that the planet moved in an orbit totally different from that furnished by the calculations. LeVerrier and Adams had obtained an ellipse, with a mean distance from the sun nearly in accordance with Bode's Law. The actual planet moved in an orbit nearly circular and paid no attention whatever to the law!

The failure of Bode's Law, as indicated by the preliminary orbits of Neptune, came as a distinct shock. Astronomers refused to believe, and preferred to distrust the orbit computations.

To obtain a better orbit, there was only one of two things to do:—to await the accumulation of a number of years' observations or, as was the case with Uranus in the early years following that planet's discovery, to search through the old star catalogues in the hope of finding observations of Neptune unwittingly recorded there as of a fixed star.

Such an observation was actually discovered. Two astronomers, working independently and by different methods, the one at his desk, and the other with his telescope, the one in America and the other in Europe, came almost simultaneously to the same conclusion, that a star recorded as observed on the night of May 10, 1795, in a position of the heavens where Neptune had probably at that time had its course, was now missing from the firmament. A little investigation showed this star to have been the planet. It showed further that had the observer exercised a little more care he could not have failed to anticipate the discovery of Neptune by fifty years.

The discovery of this observation, by extending the observed arc of Neptune over one third of the planet's course, furnished ample material for the computation of a good orbit.

These curious developments had meanwhile aroused the interest of Professor Benjamin Peirce, and this eminent American mathematician now turned the glare of his profound intellect upon the problem of Neptune. Following upon a long series of researches, he announced one evening to a learned audience that:

"The planet Neptune is not the planet to which geometrical analysis had directed the telescope; that its orbit is not contained within the limits of space which have been explored by geometers searching for the source of the disturbances of Uranus; and that its discovery by Galle must be regarded as a happy accident."

This statement, apparently grounded upon firm analysis, and coming from a recognized authority, astounded the world. And no wonder. LeVerrier had predicted the position of an undiscovered planet; the prediction had been made independently some months earlier by another investigator, Adams; and in the predicted place, and having the predicted attributes, the planet had been found. Men had marvelled, and termed the discovery of the planet a wonderful witness to the power

of the intellect. Were they now to believe that so sublime a discovery was, after all, nothing more than a "happy accident?"

It often happens that a mathematical problem affords more than one solution. Such, said Peirce, was the case with the problem of Uranus. The irregularities in the motion of Uranus could be accounted for by the disturbing action of any one of several theoretical bodies. The actual planet Neptune is such a body; so also is the hypothetical planet of Adams and LeVerrier. The "happy accident" lay in the singular circumstance that these two solutions of the problem, though differing widely in every other particular, agreed at the time of discovery in the matter of their direction from the earth, so that a telescope pointed at one pointed also at the other. As for the coincidence that LeVerrier and Adams had arrived at the same solution, that was to be explained by the fact that in their researches they had both been led astray by too firm reliance upon Bode's Law.

Peirce went further and assailed the theory employed by LeVerrier and Adams, maintaining that in their investigations they had employed inaccurate formulae. Though the justice of this criticism has been questioned, later developments seem to indicate that the criticism was not unfair. "Nor can I believe", says the present Astronomer Royal of Scotland, "that if Adams or LeVerrier could have foreseen the immense difference of form between their own formulae and the truth, they could have had the same confidence in the exactness of the predicted places."

Throughout the bitter controversy that followed, Peirce at no time contested the genius of the theoretical discoverers. He drew a sharp distinction between the task of the mathematician and that of the astronomer, and pointed out that Adams and LeVerrier, in demonstrating the existence of a disturbing body, and obtaining a solution which, though hypothetical, could have accounted for the motion of Uranus had it had a real existence, had performed the task required of the mathematician, and were consequently entitled to all the praise and reward that would have been theirs had the solution proved to be the actual solution of nature.

LeVerrier, nevertheless, did not take kindly to the criticism. He was unwilling to grant that Neptune was not the planet of theory. He refused at first to admit that Neptune moved in any other than the predicted orbit; and casting slurs upon the orbit computations declared that the results of the computations were incompatible with the nature of the perturbations

of Uranus. Forced eventually to retreat from this position, he hit upon the explanation that just as Uranus was influenced by Neptune, so Neptune perhaps was disturbed by a trans-Neptunian planet. The hypothesis of a trans-Neptunian planet became untenable, however, when Peirce showed that Neptune, though moving in an orbit different from that predicted, could account for all the perturbations of Uranus with the most surprising accuracy. LeVerrier accordingly reverted to his former stand, and maintained stoutly that Neptune was none other than the predicted planet.

Adams, unlike LeVerrier, took no part in the discussion. It was not until many years later, and then upon a most fitting occasion, that he took it upon himself to remark that though in certain particulars Peirce was right, yet so far as the problem under consideration was concerned,—the problem of assigning a position in the heavens where the theoretical planet might be sought for,—the criticism was without force. Though admitting that in the discovery of Neptune there was an element of chance, he nevertheless joined his impulsive French contemporary in the assertion that Neptune and the predicted planet were the same.

To what extent the discovery of Neptune was fortuitous is a question perhaps still open to argument. Certain it is that both Peirce and LeVerrier, in the course of their controversy, gave utterance to statements apparently paradoxical and self-contradictory. Peirce maintained to his dying day the accuracy of his views; and this after he had resumed his researches, and carried them on extensively. Other astronomers, on the other hand, have as firmly maintained the contrary.

Astronomers of the present day have little faith in the existence of more than one solution. Unfortunately, Peirce never published more than a very brief summary of only a portion of his researches. It is devoutly to be wished that some competent mathematician would investigate the original manuscripts.

V. Conclusion.

A word with regard to the supposed trans-Neptunian planets.

Ever since the discovery of Neptune, astronomers have lived in the hope of finding a planet even more remote from the sun. LeVerrier himself was perhaps the first to express this hope, and uttered the remarkable thought that the existence of this planet might be detected mathematically, though it be too small and too far away to permit of telescopic vision. Several

astronomers have done considerable work on the problem, but the telescopic search of the heavens based on their researches has proved fruitless.

Whether or not a trans-Neptunian planet has actual existence must be left for time to tell. Of one thing, however, we may rest almost certain. The circumstances attending the discovery of such a planet will hardly be of so extraordinary a nature as those interwoven with the discovery of Neptune.

A GREAT SOLAR OUTBURST.

ALFRED FORDAME.

The single large sunspot which made its appearance on the sun during the latter part of June at first sight seemed to be of the normal or quiescent round type; but upon examination with a high power on the 6-inch telescope, it showed a wealth of detail almost baffling in its complexity to the delineator. I have tried however to show it as I saw it at the time of its maximum activity at 9 a. m. Mountain time, on June 24th. There is evidence here of cyclonic action, and the luminous "bridges" suggests the tumbling of incandescent vapor into a stupendous chasm. The next day was cloudy, but on the 26th another view was had, and a drawing made, which shows the spot nearing the western edge of the sun. The same apparent cyclonic action seemed to manifest itself, but this time in a less degree and on the *opposite side* of the spot. It was also growing smaller and broke up on the opposite side of the sun, for on the return of the same region in the middle of this month, only the enormous faculae, which surrounded it at all times during its progress across the sun, were visible.

As before stated the detail visible in a properly equipped telescope is almost beyond the capacity of any draughtsman to portray properly, and it is a pity that photography is not as yet able to give us any but the most obvious of the larger details, which of course are given much more faithfully than in any drawing. It is to be hoped that the giant reflector on Mt. Wilson will be tried in solar photography and will give us the detail visible to the eye in the same way that the wonderful spectro-heliohraph of Professor Hale portrays the invisible calcium and hydrogen flocculi.

The relative size of the earth on the same scale as the drawing is only a rough approximation, but does well enough to give us an idea of the tremendous forces at work on the sun.

Salt Lake City, July 20th.

1912 June 24, 9:00 A. M. Mountain Time.

1912 June 26, 8:30 A. M. Mountain Time.

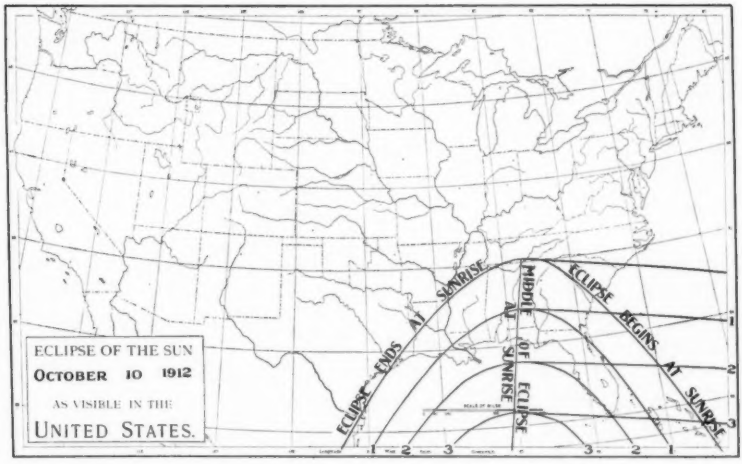
A GREAT SUNSPOT.

Drawn by Alfred Rordame, Salt Lake City, Utah.

THE SOLAR ECLIPSE OF 1912 OCTOBER 10 AS VISIBLE IN THE UNITED STATES.

WILLIAM F. RIGGE.

The total eclipse of the sun of 1912 October 10 will be visible in the United States as a partial eclipse only and only in a few states. In the accompanying map the meaning of the marked curves is sufficiently evident without explanation. To the west of the line denoting the Middle of the Eclipse at



Sunrise the sun will rise with 1, 2, or 3 tenths of its diameter obscured as the corresponding curves indicate, and the eclipse will then be decreasing. To the east of this Middle Line the sun will rise similarly eclipsed, but the obscuration will increase until it reaches the magnitude shown by the other parallel lines which start at right angles to this Middle Line and run eastward.

Creighton University Observatory,
Omaha, Nebraska.

THE STELLAR UNIVERSE IN THE LIGHT OF RECENT INVESTIGATIONS.

HECTOR MACPHERSON, JR, F.R.A.S.

Within the last few years, there has been a remarkable extension of our knowledge of isolated facts connected with the Stellar Universe; and on these facts, discovered after laborious investigation, important theories have been propounded which have a profound bearing on the great problem of the structure of the heavens. The difficulty has hitherto been to reconcile the various facts and theories which flow from them; and undoubtedly this is the supreme task before the astronomers of the future.

In a previous paper in POPULAR ASTRONOMY (1907) the writer traced the development of our knowledge of the distribution of the stars. As mentioned in that paper, there are several well-ascertained facts regarding the stellar system which may be mentioned here: (1) The clustering of the stars towards the plane of the Galaxy. This is obvious even in the case of the brighter stars, as was shown by Proctor, Schiaparelli and Gore. That it holds good in the case of star-fields scattered at random over the sky was shown in a paper read by the present writer at the Astronomical Institution of Edinburgh in 1909. (2) The greater preponderance on and near the Galaxy of stars of Secchi's first spectral type (Vogel's type I). (3) The existence of streams of stars,* which are probably more numerous in the Galaxy than elsewhere. This was shown by Gore and noted in an investigation by the present writer in 1911.

So much for what is obvious and incontrovertible. The Galaxy is the ground plan of the Universe—"the equator of the stars," a region of stellar aggregation.

In 1893 Professor Kapteyn propounded his famous theory of the solar cluster, derived from his statistical investigation of stellar motions. He found that stars of the first spectral type have smaller proper motions than those of the second, indicating that second type stars are on the average nearer to the Solar System than those of the first type. The conclusion which Kapteyn drew was that the near vicinity of the

* The term "streams of stars" used here is defined by the writer of the present article in Vol. XIX p. 603 as "a line, curve, chain, or festoon of stars in which the imaginary line joining the individual stars is either a straight line or a symmetrical curve." This sense is different from that in which "star-streams" is used in connection with Professor Kapteyn's theory. Ed.

sun consisted almost exclusively of stars of the solar type, these stars with the sun forming a connected system, roughly spherical in shape. This system Kapteyn named "the solar cluster."

The theory enjoyed considerable popularity until it was abandoned by its author in 1902. A few years later, in 1907, Kapteyn gave to the world the results of his subsequent investigations, and put forward as a working hypothesis his new theory of two star-streams. A statistical investigation on proper motion led him to the discovery of the general drift of the mass of the stars in two opposite directions in the plane of the Galaxy; and his conclusion was confirmed by Mr. Eddington, of Greenwich, in an independent investigation in 1907.

Regarding this discovery Mr. Eddington makes the following remarks: "It is a significant fact that this line of symmetry of the stellar motions lies in the plane of symmetry of stellar distribution; it establishes some sort of connection between the two phenomena. This preference for moving in one of two opposite directions is most naturally explained by supposing that we have to do with two independent streams of stars which have become intermixed; but whilst there is much to be said for this view, it admittedly goes a little beyond what the observations strictly entitle us to assert."

Two other theories have been put forward, which explain the observed facts equally with the hypothesis of two star-streams. Schwarzschild of Potsdam, a German astronomer, worked out some years ago what has been called the ellipsoidal theory. Instead of regarding the universe as dual and consisting of two star-streams, Schwarzschild holds to the unitary theory; and Mr. Eddington admits that "if a definite physical difference between the stars of the two drifts could be proved, the unitary theory would be no longer tenable; but no such difference has been established." In other words, the shape of the Universe of stars was originally that of an elongated ellipsoid; the opposite drift of the two star-streams would then be due to the two extreme ends of the ellipsoid falling in towards the central regions. The advantage of Schwarzschild's hypothesis is that it holds to the unity of the stellar system. A third theory which postulates the existence of three instead of two star-streams, was put forward by Halm, of the Cape Observatory. From a new investigation, he concluded that stream I of Kapteyn's theory was really double and that one of the

sub-streams constituting it was directed towards the antapex of the solar motion. Which, if any, of the theories advanced is the correct one, it is as yet impossible to determine.

Several other important facts connected with the streaming of the stars have also been noted.

I. Helium or Orion stars (stars of Vogel's type O) do not share in the streaming motion of the two great drifts. In fact, the motions of these stars are very inconsiderable. Owing to their great brilliancy they are probably visible from an enormous distance and are probably situated, as Mr. Eddington pointed out in 1911, in the outer portions of the Universe. The same astronomer remarked that "the two star-streams probably involve at least half a million of the stars around us; but there has never been any evidence that they prevail in the extremely remote parts, where helium stars are thinly scattered." Kapteyn, however, differs from this view. He finds that the streaming system is not confined to the vicinity of the sun, but is universal.

II. Stars of the type I have been shown by Dyson to diverge in their motions from the stream in which they are included much less than later types. This was confirmed by Weersma.

III. The investigations of Campbell, of the Lick Observatory, and Hough and Halm, of the Cape, on the radial motions of the stars, confirm the stream theory.

IV. "The relation of spectral type and velocity" says Eddington "is one of the most startling of the results of modern astronomy". The stars of Vogel's type O have the smallest individual velocities; the velocities of stars of this type are about a third of those of the later types. This seems to indicate that stars evolve from nebulae with practically no motion. Movement is ultimately developed, either as the same astronomer suggests by the casual interference of the stars in the vicinity or by the combined gravitational pull of the stellar system itself.

V. The existence of smaller streams has long been admitted and is now recognized to be a well attested fact in astronomy. The cases of the Plough and the Pleiades are well known. Whole systems drift in the same direction with the same velocity. "The existence of clusters such as these" says Eddington "seems necessarily to prove that the forces which produce the individual velocities of stars are nearly constant over large volumes of space. Hence it is the central attraction of the

Universe as a whole, and not the attraction of the immediate neighbors, that is effective in changing a star's velocity."

In the midst of these varying discoveries of facts and tendencies, the problem is to reach the true theory of the Universe. Has the two-stream theory come to stay or will it go the way of the hypothesis of the solar cluster? The latter theory for a time held the field; but later investigations convinced Kapteyn that it was untenable. The stream-theory, however, seems to be more probable. That the stars, generally speaking, drift in two opposite directions has been confirmed by investigators other than Kapteyn. The differences between astronomers consist in the difficulty of interpreting the streaming phenomenon.

Professor Turner of Oxford, however, believes that the different theories may turn out to be all true; and at a recent meeting of the Royal Astronomical Society (March 1912) he put forward his views. In his own words which may be as well quoted here—"What is an extreme form of motion with reference to a centre? It would of course be motion straight to or from the centre—radial motion. What would happen then? All stars moving towards the centre of the system would seem to intersect in the centre; and then there would be another set coming away, and they would seem to diverge from the centre and converge to the opposite point of the celestial sphere; that would explain the star-streams, with no distinction between them beyond the simple fact that when there are stars visiting the centre some must be going and some coming back."

Turner's theory has the merit of simplicity, which the hypothesis of two independent streams of stars lacks; and probably it will be found true that the visible Universe is a unit, not a dual system. But obviously it will be many years before any of these theories can be put forward as other than merely provisional. The material at our disposal in regard to radial motions is too limited to lay down a theory with any degree of dogmatism.

The recent speculations do not touch the subject of the centre of gravity of the Universe, but if Turner's theory be near the truth it would seem that there must be some central point. It is somewhat remarkable that in *The Observatory* for April last, Mr. F. W. Henkel draws attention to Mädler's theory of the "Central Sun," long since abandoned and generally believed to be utterly discredited. Mr. Henkel does not revive Mädler's theory, but he pleads for a repetition of the line of work by

which Mädler was led to his conclusion that the Pleiades occupied the central position. He points out that the common proper motion and similarity of spectra characterising the Pleiades group adds probability to the suggestion that they might form *a physical centre* for the motions of other stars.

Recent astronomical work has been directed chiefly to the systematic motion of the stars, and only in a lesser degree to their distribution and to the extent of the Universe. But there seems no reason to modify the opinion generally held—that roughly speaking, the Universe is globular, with increasing condensation to the equatorial region (the Galaxy), and that the stellar system visible to us is limited in extent. Undoubtedly the galaxy is the ground plan of the Universe—the reference plane. The stars converge towards it; stellar motions, as the stream theory shows, are arranged with reference to it; temporary stars are commonest in or near the galactic equator. The crowding of variable stars of all types to the Milky Way has been brought out recently by the German astronomer Zinner, who has shown the enormous preponderance of variables in the galaxy. In the galactic latitude $+10°$ to $-10°$ there are 422 of the variables in his list. In galactic latitude $+90°$ to $+70°$, there are only 10. There is a steady increase from the galactic poles to the galaxy itself. Thus variable stars, temporary stars, clustering regions and regions of streaming seem to be much more numerous in the galactic regions than elsewhere. The galactic region seems to be in an earlier stage of evolution than other parts of the Universe. Perhaps the most remarkable fact concerning the Stellar Universe is that of apparent stability and actual motion. The stars are in continual motion and yet their relative positions remain practically unchanged. For instance, we talk of the *motions* of the planets, but we cannot talk of their distribution. On the other hand, we can talk both of the *motions* and *distribution* of the stars. Owing to the common drift of so many stars, and owing to the vast distances separating them, their relative positions change very little. If the Ancient Greek astronomers were alive to-day, they would detect little change in the positions of the stars—a fact due to the immensity of the Universe, the huge scale on which it is constructed.

VARIABILITY OF POLARIS.

EDWARD S. KING.

Shakespeare makes Caesar say:—

> "But I am constant as the northern star,
> Of whose true-fixed and resting quality
> There is no fellow in the firmament."

Bryant in his "Hymn to the North Star" speaks of its "unaltering blaze," and calls it

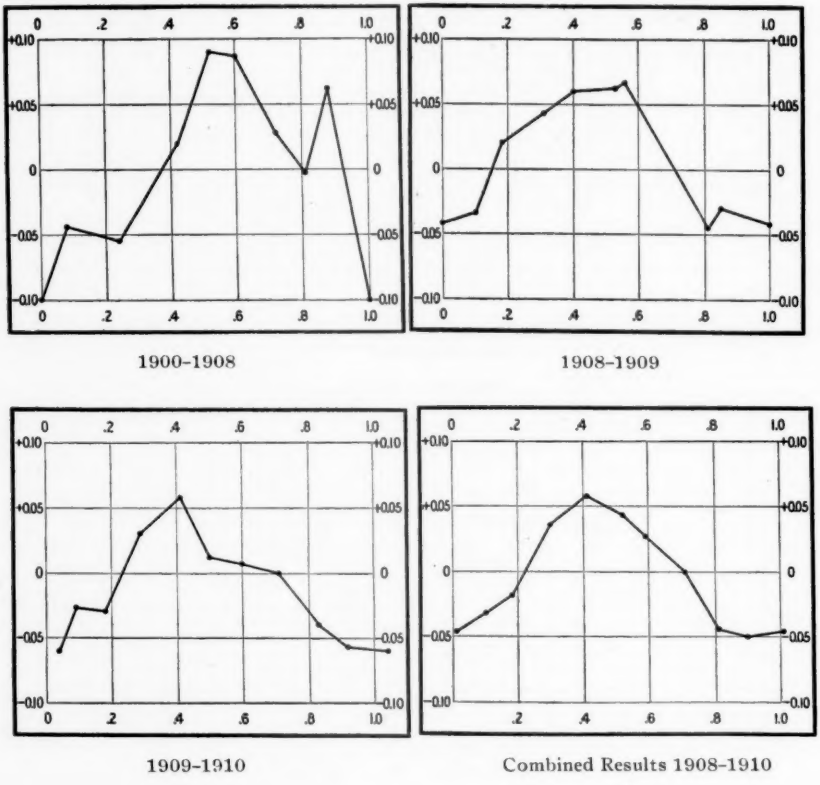
> "A beauteous type of that unchanging good."

Constancy in light as well as in position appears to be a popular impression with respect to the Pole Star. Indeed, even some astronomers have said that it "is perhaps the star in all the sky of whose constancy in light we may be most certain." Thus, the announcement by Dr. Hertzsprung of his discovery of the variability of Polaris commanded more than ordinary interest.

In my work of photographing the bright stars out-of-focus, at the Harvard College Observatory, to obtain standard photographic magnitudes, I have constantly used Polaris as a means of comparison. In the several investigations covering a period of ten years, I had noticed certain systematic differences and had tried to prove them due to a long period variation in Polaris, but without success. The announcement by Hertzsprung that the variability corresponded to the spectroscopic period of about four days simplified the problem immensely. In general, all my stars had been observed on at least five different nights. The observations for each night consisted in photographing 10 to 20 stars with Polaris on the same plate, at such foci that all the images should be of nearly equal density. A few extra images of Polaris, made at other foci, so that some images would be darker and others fainter than the average for the plate, gave an accurate scale of magnitudes. The comparison was made with Polaris in all cases.

In compiling the results, I found that for some nights all the stars would appear brighter, and on other nights fainter, than the average brightness. This would be precisely the effect of a variation in the light of Polaris. Of course, such differ-

ences might be due more or less to other causes. These variations for the night, however, when grouped according to the given spectroscopic period, showed conclusively the variability of Polaris, and confirmed Hertzsprung's discovery. The three



THE LIGHT CURVE OF POLARIS.

separate investigations, which I had made, all gave light curves of substantially the same form, which are shown in the accompanying figures. The figure showing the combined results for 1908-1910 is so closely represented by a sine curve that the average deviation for the 10 points is only $\pm$ 0.0056 magn. The range in brightness is 0.108 magn. The range found by Hertzsprung was 0.171 magn. More recently, Professor Stebbins has derived a value of 0.078 magn. by means of the

selenium photometer, and Professor E. C. Pickering a value of about 0.15 magn, from the records of the Meridian Photometer.

The question is occasionally asked, "What effect will the variability of Polaris have on the Harvard magnitudes?" The answer is, "None whatever." In all cases, the ultimate standard of reference has not been Polaris, but a large body of stars. In the out-of-focus work, the difference for the night, as I have called it, was applied as a correction to the results for the night. The application of such corrections has had the same effect as if I had known Polaris to be a variable. That these were fairly good corrections for variability is shown by the similarity of the light curves derived from the several investigations. Thus, it is seen that by using this method to correct for a possible error a real source of error was eliminated.

In conclusion, I may say that no special plates or measures have been made, but that I have derived all the material from matter already in type. A full account of this investigation will be found in the Annals of the Harvard College Observatory, Vol. 59, No. 10.

PLANET NOTES FOR NOVEMBER, 1912.

The sun will continue its motion southward during this month. By the end of the month it will be within less than two degrees of its farthest point south. It will move eastward from the constellation Libra into Scorpio, and at the end of the month will be about five degrees north of Antares.

The phases of the moon for this month are as follows:

Last Quarter	Nov. 1 at	9 P. M.	C. S. T.
New Moon	8 "	8 P. M.	"
First Quarter	16 "	4 P. M.	"
Full Moon	24 "	10 A. M.	"

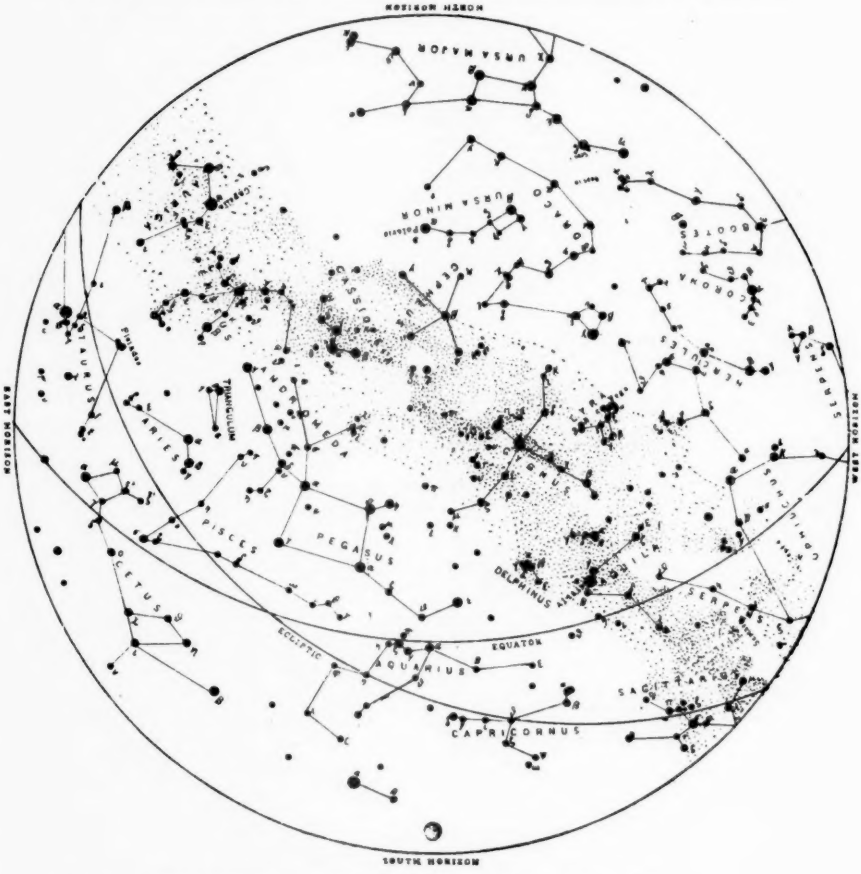
Mercury will reach its greatest elongation east on November 19. At this time it will be about an hour and a half east of the sun, but being several degrees south it will set about an hour after the sun. It will be visible low in the west just after sunset near this date.

Venus will move eastward more rapidly than the sun and will be higher in the western sky each succeeding night. It will also be several degrees south of the sun. It will be the evening star, and will be conspicuous because of its brilliancy.

Mars will be in conjunction with the sun on November 4. It will move eastward at nearly the same rate as the sun and will not be visible during this month. Mars will be approaching the earth during this month.

Jupiter will still be visible in the southwest after sunset in the early part of the month. By the end of the month it will be too near the sun for observation.

Saturn, as well as being one of the most interesting planets for observation, will also be the most favorably situated during this and the following months.



THE CONSTELLATIONS AT 9:00 P. M. OCTOBER 1, 1912.

It will be in opposition on November 22, and will consequently rise at sunset. It will have a slow westward motion. It may easily be recognized in the sky because it will be in the same part of the sky as the Pleiades. It need not be confused with Aldebaran which is also in that region, because Aldebaran has a decidedly reddish tinge and Saturn is more nearly white.

Uranus will be west of the meridian at sunset. It will move slowly eastward in the constellation Capricornus, rather low in the south.

Neptune will rise a few hours after sunset. It will move westward about one minute of arc during the month. It will be in the constellation Gemini.

Occultations visible at Washington.

Date 1912	Star's Name	Magnitude	IMMERSION. Washington M.T. h	m	Angle from N. °	EMERSION. Washington M.T. h	m	Angle from N °	Duration h	m
Nov. 2	107 B Leonis	6.3	14	3	49	14	42	354	0	29
15	ϕ Capricorni	5.3	9	54	3	10	30	296	0	36
20	171 B Piscium	6.3	10	40	45	11	57	241	1	17
23	τ Arietis	5.1	4	29	54	5	20	256	0	51
23	104 B Tauri	5.5	18	32	80	19	22	263	0	50
25	107 B Aurigæ	6.5	10	18	135	10	57	198	0	39
25	406 B Tauri	5.6	17	52	95	18	51	278	0	59
26	49 Aurigae	5.1	7	59	19	8	23	328	0	24
27	c Geminorum	5.5	9	38	149	10	10	216	0	32
27	ω Cancri	5.9	18	13	38	18	29	9	0	16
27	4 Cancri	6.2	18	24	100	19	28	306	1	04

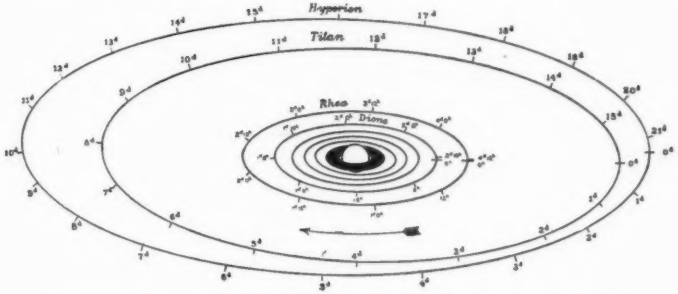
Saturn's Satellites.

CENTRAL STANDARD TIME.

E = eastern elongation; W = western elongation.
I = inferior conjunction; S = superior conjunction.

I. Mimas. Period $0^d\ 22^h.6$.

		h			h			h			h
Nov.	1	9.1 E	Nov.	8	10.8 W	Nov.	16	10.9 E	Nov.	23	12.6 W
	2	7.7 E		9	9.4 W		17	10.5 E		24	11.2 W
	3	6.4 E		10	8.1 W		18	8.2 E		25	9.9 W
	4	16.4 W		11	6.7 W		19	6.8 E		26	8.5 W
	5	15.0 W		13	15.1 E		20	5.4 E		27	7.1 W
	6	13.6 W		14	13.7 E		21	15.4 W		28	5.7 W
	7	12.2 W		15	12.3 E		22	14.0 W		29	15.5 E
										30	14.1 E



APPARENT ORBITS OF THE SEVEN INNER SATELLITES OF SATURN, at date of opposition, November 23, 1912, as seen in an inverting telescope.

II. Enceladus. Period $1^d\ 8^h.9$.

Nov.	1	12.9 E	Nov.	9	18.1 E	Nov.	17	23.4 E	Nov.	24	19.7 E
	2	21.8 E		11	3.0 E		19	8.2 E		26	4.9 E
	4	6.6 E		12	11.9 E		20	17.1 E		27	13.5 E
	5	15.5 E		13	20.7 E		22	2.0 E		28	22.4 E
	7	0.4 E		15	5.6 E		23	10.9 E		30	7.2 E
	8	9.5 E		16	14.5 E						

III. Tethys. Period $1^d\ 21^h.3$.

Nov.	1	0.7 E	Nov.	8	13.9 E	Nov.	16	3.0 E	Nov.	23	16.1 E
	2	22.0 E		10	11.1 E		18	0.3 E		25	14.3 E
	4	19.3 E		12	8.4 E		19	21.6 E		27	11.6 E
	6	16.6 E		14	5.7 E		21	18.9 E		29	8.0 E

IV. Dione. Period $2^d\ 17^h.7$.

Nov.	3	13.3 E	Nov.	11	18.3 E	Nov.	19	23.2 E	Nov.	28	4.1 E
	6	7.0 E		14	11.9 E		22	16.8 E		30	21.8 E
	9	0.6 E		17	5.6 E		25	10.5 E			

V. Rhea. Period $4^d\ 12^h.5$.

Nov.	2	13.8 E	Nov.	11	14.4 E	Nov.	20	15.0 E	Nov.	29	15.6 E
	7	2.1 E		16	2.7 E		25	3.3 E			

VI. Titan. Period $15^d\ 23^h.3$.

Nov.	3	7.6 W	Nov.	11	8.1 E	Nov.	19	4.8 W	Nov.	27	5.3 E
	7	5.2 S		15	9.1 I		23	2.4 S			

VII. Hyperion. Period $21^d\ 7^h.6$.

Nov.	d 2.8 W		Nov.	d 13.9 E		Nov.	d 24.1 W		Nov.	d 30.1 S	
	8.9 S			18.6 I							

VIII. Japetus. Period $79^d\ 22^h.1$.

Oct.	22.8 S		Nov.	11.8 E		Dec.	2.1 I				

IX. Phoebe. Period $580^d\ 4^h.7$.

	α Ph.—α Sat.			δ Ph.—δ Sat.			α Ph —α Sat.			δ Ph.—δ Sat.	
	m	s		°	′		m	s		°	′
Nov. 1	2	45.9		+0	11.6	Nov. 16	2	45.0		0	12.3
6	2	46.0		0	11.8	21	2	43.8		0	12.4
11	2	45.7		0	12.1	26	2	42.2		+0	12.5

Dark Spot on Jupiter.—Mr. J. J. Schafer, a member of the Planetary and Lunar Secion of the Society for Practical Astronomy, reports unusual activity in the north equatorial belt of Jupiter. On August 23, 1912, a dark spot was seen in the faint belt and its longitude on the 25th was 198°. On Sept. 1, this was practically unchanged, according to an observation by the director of the section. The spot apparently belongs to System II. As seen with the 11-inch reflector the disturbed area consists of several dark condensations, as though the white matter which has partly obscured the belt was beginning to clear away.

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The Diameter of Neptune.—In *Memorie della Società degli Spettroscopisti Italiani* Mr. G. Abetti discusses all the available measures of the planet Neptune, and concludes that at its mean distance from the sun the apparent diameter of Neptune is 2″.29. The following table shows the range of the apparent diameter with the varying distance.

Distance	Apparent Diameter
28.8	2.″39
29.0	2 .38
30.0	2 .30
31.0	2 .23
31.4	2 .20

VARIABLE STARS.

Approximate Magnitudes of Variable Stars on Sept. 1, 1912.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900. h m	Decl. 1900. ° ′	Magn.
X Androm.	0 10.8	+46 27	12.0	R Draconis	16 32.4	+66 58	<11.0
T Cassiop.	17.8	+55 14	8.3*d*	S Herculis	47.4	+15 27	10.3
Y Cephei	31.3	+79 48	<13.0	RV Herculis	56.8	+31 2	12 0
RW Androm.	41.9	+32 8	<12.0	R Ophiuchi	17 2.0	−15 58	<12.0
RV Cassiop.	47.1	+46 53	<13.0	RT Herculis	6.8	+27 11	<12.0
W Cassiop.	49.0	+58 1	12.2	Z Ophiuchi	14.5	+ 1 37	9.0*d*
U Androm.	1 9.8	+40 11	<13.0	RS Herculis	17.5	+23 1	9.9 *i*
— Androm.	10.4	+41 12	<14 0	RU Ophiuchi	28.5	+ 9 30	<11.0
S Cassiop.	12.3	+72 5	<12.0	RS Ophiuchi	44.8	− 6 40	<11.0
RZ Persei	23.6	+50 20	9.8	T Draconis	54.8	+58 14	<10.0
RU Androm.	32.8	+38 10	11.0*d*	RY Herculis	55.4	+19 29	<11.0
X Cassiop.	49.8	+58 46	11.0	V Draconis	56.3	+54 53	10.7 *i*
W Androm.	2 11.2	+43 50	<12.0	T Herculis	18 5.3	+31 0	<11.0*d*
Z Cephei	12.8	+81 13	<13.0	W Draconis	5.4	+65 56	12.1*d*
o Ceti	14.3	− 3 26	6.5*d*	X Draconis	6.8	+66 8	<12.0
S Persei	15.7	+58 8	9.4 *i*	W Lyrae	11.5	+36 38	11.3*d*
RR Persei	21.7	+50 49	11.7*d*	Y Scuti	32.6	− 8 27	<11.0
RR Cephei	29.4	+80 42	<13.0	SV Draconis	31.2	+49 18	9.0
T Arietis	42.8	+17 6	<11.0	RY Lyrae	41.2	+34 34	11.8*d*
W Persei	43.2	+56 34	10.2	R Scuti	42.2	− 5 49	5.7
X Camelop.	4 32.6	+74 56	<10.0	Z Lyrae	56.0	+34 49	<12.0
R Leporis	55.0	−14 57	8.3	V Lyrae	19 5.2	+29 30	<13.0
R Aurigae	5 9.2	+53 28	9.3 *i*	S Lyrae	9.1	+25 50	9.8
S Aurigae	20.5	+34 4	<10.0	UDraconis	9.9	+67 7	9.3
U Orionis	49.9	+20 10	8.9*d*	U Lyrae	16.6	+37 42	10.3
V Camelop.	49.4	+74 30	<12.0	R Cygni	34.1	+49 58	12.5
Nova Gem.	6 45.5	+32 17	7.6	RT Cygni	40.8	+48 32	7.6
S Can. Min.	7 27.3	+ 8 32	<11.0	X Cygni	46.7	+32 40	6.1
Y Draconis	9 31.1	+78 18	<13.0	Z Cygni	58.6	+49 46	10.5*d*
R Urs. Maj.	10 37.6	+69 18	8.3 *i*	SV Cygni	20 6.5	+47 35	8.8
T Urs. Maj.	12 31.8	+60 2	<12.0	R Sagittae	9.5	+16 25	8.5 *i*
RS Urs. Maj.	34.4	+59 2	13.5*d*	RS Cygni	9.8	+38 28	7.2
S Urs. Maj.	39.6	+61 38	11.4*d*	R Delphini	10.1	+ 8 47	<12.0
R Can. Ven.	13 44.6	+40 2	9.3*d*	V Sagittae	15.8	+20 47	<11.0
U Urs. Min.	14 15.1	+67 15	10.3*d*	U Cygni	16.5	+47 35	10.0*d*
S Boötis	19.5	+54 16	11.3	ST Cygni	29.9	+54 38	13.4
V Boötis	25.7	+39 18	11.6*d*	TV Cygni	30.0	+46 13	9.6
R Camelop.	25.1	+84 17	8.4	V Cygni	38.1	+47 47	9.5
R Boötis	32.8	+27 10	11.3 *i*	Y Aquarii	39.2	− 5 12	<11.0
Y Librae	15 6.4	− 5 38	<11.0	T Aquarii	44.7	− 5 31	<12.0
S Cor. Bor.	17.3	+31 44	11.5	R Vulpeculae	59.9	+23 26	10.2*d*
S Urs. Min.	33.4	+78 58	11.4*d*	VV Cygni	21 2.3	+45 23	<11.0
R Cor. Bor.	44.4	+28 28	6.2	X Cephei	3.6	+82 40	<13.0
X Cor. Bor.	45.2	+36 35	10.2*d*	R Equulei	8.4	+12 23	<13.0
R Serpentis	46.1	+15 26	9.2*d*	T Cephei	8.2	+68 5	6.8 *i*
Z Cor. Bor.	52.2	+29 32	12.7	W Cygni	32.2	+44 56	6.8*d*
X Herculis	59.6	+47 31	6.1	S Cephei	36.5	+78 10	10.2*d*
Z Scorpii	16 0.1	−21 28	<10.0	RU Cygni	37.3	+53 52	9.0
R Herculis	1.7	+18 38	8.9	RV Cygni	39.1	+37 34	7.9
U Serpentis	2.5	+10 12	<12.0	V Cassiop.	23 7.4	+59 8	7.6
RU Herculis	6.0	+25 20	9.1	ST Androm.	33.8	+35 13	9.5
W Ophiuchi	16.0	− 7 28	<10.0	Z Cassiop.	39.7	+56 2	11.0
U Herculis	21.4	+19 7	<12.0	R Cassiop.	53.3	+50 50	9.6*d*
R Urs. Min.	31.3	+72 28	8.9	Y Cassiop.	58.2	+55 7	<12.0

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign <, that the variable is fainter than the appended magnitude. The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:— T. C. H Bouton, A. P. C. Craig, T.Dunham, E.L. Forsyth, Edward Gray, F.E. Hathorn, C. J. Hudson, S. E. Hunter, M. W. Jacobs, Jr., J. B. Lacchini, C. Y. McAteer, P. G. O'Reilly, W. T. Olcott, H. W. Vrooman, and I. E.Woods.

Minima of Variable Stars of the Algol Type.

[Calculated by Mary H. Wilson at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard 6^h, etc.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in November 1912. d h d h d h d h
SV Androm.	0 08.0	+43 09	9.5—13.0	34 21.6	
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	1 5; 7 4; 19 1; 30 23
U Cephei	0 53.4	+81 20	7.1— 9.2	2 11.8	4 13; 9 13; 19 12; 29 11
Z Persei	2 33.7	+41 46	9.4—12.	3 01.4	1 0; 7 3; 19 8; 25 11
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	5 23; 12 20; 19 17; 26 14
RZ Cassiop.	39.9	+69 13	6.4— 7.8	1 04.7	4 7; 10 6; 22 5; 28 4
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	4 3; 9 11; 20 1; 30 15
RX Cephei	2 58.8	+67 11	8.6— 9.1	32 07.6	1 15
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 12; 11 6; 22 17; 28 11
RT Persei	16.7	+46 12	9. —11.	0 20.4	2 4; 7 6; 17 11; 27 15
λ Tauri	55.1	+12 12	3.4— 4.5	3 22.9	5 3; 13 0; 20 22; 28 20
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	2 19; 8 8; 19 10; 30 11
RV Persei	4 04.2	+33 59	10.6—12.8	1 23.4	4 0; 9 22; 21 19; 27 17
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	7 13; 20 17
RS Cephei	4 48.6	+80 06	9.5—12.2	12 10.1	4 10; 16 20; 29 6;
RY Aurigæ	5 11.5	+38 13	10.7—11.7	2 17.5	2 13; 8 0; 18 22; 29 20
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	1 7; 7 7; 19 8; 25 9
SV Gemin;	54.6	+24 28	9.8—<11	4 00.2	5 7; 13 7; 21 8; 29 8
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	2 15; 8 9; 19 20; 25 13
U Columbæ	6 11.2	−33 03	9.4—10.2	2 19.2	4 0; 9 15; 20 19; 26 10
SX Gemin.	22.	+20 37	10.8—11.5	1 08.8	2 6; 7 18; 18 16; 29 14
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	1 17; 9 8; 16 23; 24 14
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	8 19; 20 24
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	3 15; 9 0; 19 19; 30 13
R Canis Maj.	7 14.9	−16 12	5.9— 6.7	1 03.3	5 4; 10 20; 22 5; 27 21
RY Gemin.	7 21.7	+15 52	8.9—<10	9 07.2	1 0; 10 8; 19 15; 28 22
Y Camelop	27.6	+76 17	9.5—12.	3 07.3	4 2; 10 17; 23 22; 30 13
RR Puppis	43.5	−41 08	9.5—	6 10.3	2 10; 8 21; 21 17; 28 4
V Puppis	55.4	−48 58	4. — 5.	1 10.9	4 22; 12 4; 19 11; 26 17
X Carinæ	8 29.1	−58 53	7.8— 8.9	0 13.0	1 22; 7 8; 18 4; 28 24
S Cancri	8 38.2	+19 24	8. —10.	9 11.6	6 17; 16 4; 25 16
S Velorum	9 29.5	−44 46	7.8— 9.5	5 22.4	1 16; 7 15; 19 12; 25 10
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	8 9; 16 19; 25 6
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	6 1; 15 7; 24 14
SS Carinæ	10 54.2	−61 23	12.2—12.8	3 07.2	5 5; 11 19; 18 9; 24 24
RW Urs. Maj	11 35.4	+52 34	9.3—10.3	7 07.9	5 21; 13 5; 20 12; 27 20
Z Draconis	11 40.6	+72 49	9.5—12.5	1 08.6	6 11; 13 6; 20 1; 26 20
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	2 11; 9 21; 17 8; 24 18
δ Libræ	14 55.6	− 8 07	5. — 6.7	2 07.9	3 10; 10 10; 17 9; 24 9
TW Draconis	15 32.4	+64 14	7.0— 8.9	2 19.4	7 18; 16 4; 24 14
U Coronæ	15 14.1	+32 01	7.8— 9.0	3 10.9	2 24; 9 22; 23 17; 30 15
SX Ophiuchi	16 12.6	− 6 25	10.5—11.2	2 01.5	6 16; 12 20; 19 1; 25 5
SW Ophiuchi	16 11.1	− 6 44	9.2—10.	2 10.7	5 2; 12 10; 19 18; 27 2

Minima of Variable Stars of the Algol Type.—Continued.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in **November** 1912 d h d h d h d h
R Aræ	16 31.1	−56 48	6.7— 8.	4 10.2	8 22; 17 18; 26 15
TT Herculis	16 49.9	+17 00	8.9— 9.5	20 18.1	2 18; 23 13
TU Herculis	17 09.8	+30 50	9.5—12.	2 06.4	4 2; 10 21; 17 16; 24 12
U Ophiuchi	11.5	+ 1 19	6. — 6.7	0 20.1	7 3; 15 12; 23 22
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	7 4; 15 9; 23 13
Z Herculis	17 53.6	+15 09	6.7— 8.0	3 23.8	7 8; 15 7; 23 7
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	5 2; 10 6; 20 14; 30 22
RS Sagittarii	11.0	−34 08	6.7— 7.8	2 10.0	2 13; 9 19; 17 1; 24 7
V Serpentis	11.1	−15 34	9.5—	3 10.9	6 21; 13 18; 20 16; 27 14
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	5 15; 11 3; 22 3; 27 15
RX Herculis	18 26.0	+12 32	7.8— 8.0	0 21.3	8 12; 17 10; 26 7
SX Sagittarii	39.7	−30 36	8.6— 9.4	2 01.8	2 14; 8 20; 21 7; 27 13
RR Draconis	40.8	+62 34	9.3—13.	2 19.9	3 13; 12 1; 20 13; 29 1
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	1 23; 8 14; 21 18; 28 19
U Scuti	18 48.9	−12 44	9.0— 9.8	0 22.9	3 7; 12 20; 22 9
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.5	1 22; 11 9; 20 20; 30 8
RV Lyræ	12.5	+32 15	11. —13.	3 14.4	3 16; 10 21; 18 2; 25 7
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	3 22; 12 21; 21 20; 30 19
U Sagittæ	14.4	+19 26	6.7— 9.0	3 09.1	6 5; 12 23; 19 17; 26 11
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	2 4; 9 12; 16 21; 24 6
TT Lyræ	24.3	+41 30	9.0<11.0	5 05.8	5 2; 10 8; 20 20; 26 2
SY Cygni	19 42.7	+32 28	10. —12.	6 00.2	1 2; 7 2; 19 2; 25 3
WW Cygni	20 00.6	+41 18	9.5—12.5	3 07.6	1 11; 8 2; 21 9; 28 0
SW Cygni	03.8	+46 01	9. —12.	4 13.8	9 16; 18 19; 27 23
VW Cygni	11.4	+34 12	9.5—11.5	8 10.3	5 10; 13 20; 22 7; 30 17
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	4 13; 11 8; 18 3; 24 21
UW Cygni	19.6	+42 55	10.5—13.	3 10.8	7 7; 14 5; 21 2; 27 24
W Delphini	33.1	+17 56	9.5—11.5	4 19.4	4 23; 14 13; 24 4
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	3 9; 12 14; 21 18; 30 23
Y Cygni	48.1	+34 17	7. — 8.	1 12.0	4 8; 11 20; 19 8; 26 20
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	4 13; 9 14; 19 16; 29 19
VV Cygni	21 02.3	+45 23	11. —14.	1 11.4	8 2; 15 12; 22 21; 30 6
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	9 21; 19 14; 29 6
UZ Cygni	55.2	+43 52	9. —11.5	31 07.3	12 7
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	4 1; 9 3; 19 6; 29 10
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	2 22; 8 2; 18 11; 28 20
TT Androm	23 08.7	+45 36	10.5—11.3	2 18.3	4 19; 13 2; 21 9; 29 16
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	7 21; 15 10; 22 23; 30 12
TW Androm.	23 58.2	+32 17	8.6—11.5	6 02.9	2 6; 10 12; 18 17; 26 23

Maxima of Variable Stars of Short Period not of the Algol Type.

[Calculated by Wallace F. Johnson at Goodsell Observatory]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h etc. An * following the name of a star signifies that for that star times of minima instead of maxima are given.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of maxima in **November** 1912. d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9·4	36 13.7	
SY Cassiop.	9.8	+57 52	9.3— 9.9	4 1.7	3 13; 11 17; 19 20; 27 23
RT Sculptor.*	0 31.5	−26 13	9.6—10.5	0 12.3	4 13; 9 16; 19 22; 30 3
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	1 0; 6 12; 17 14; 28 16

Maxima of Variable Stars of Short Period not of the Algol Type.

Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean time of maxima in November 1912.					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
RW Cassiop.	1 30.7	+57 15	8.6— 9.4	14 19 2	4 17;	19 12				
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5 4;	11 3;	23 1;	29 0		
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	4 21;	10 17;	22 10;	28 6		
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	4 4;	10 6;	22 9;	28 11		
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	6 0;	22 0				
SX Persei	4 10.2	+41 29	10.3—11.0	4 07.1	9 0;	17 14;	26 4			
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	4 9;	15 12;	26 15			
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	3 17;	15 8;	26 23			
TT Aurigæ*	02.8	+39 27	7.8— 8.7	0 16.0	5 7;	11 23;	18 15;	25 7		
SW Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	2 17;	8 20;	21 2;	27 5		
SY Aurigæ	5 05.5	+42 42	9.0— 9.7	10 03.3	1 18;	11 21;	22 0;			
Y Aurigæ	21.5	+42 21	9. —	3 20.6	4 20;	12 14;	20 7;	28 0		
SV Tauri*	45.8	+28 05	9.4—11.0	2 04.0	3 11;	9 23;	22 23;	29 11		
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	4 19;	10 8;	21 9;	26 22		
RS Orionis	6 16.5	+14 43	7.8— 8.5	7 13.4	2 17;	10 7;	17 20;	25 10		
T Monoc.	19.8	+ 7 08	6. — 8.	27 00.3	2 4;	29 5				
RZ Camelop	23.7	+67 06	11.0—12.8	0 11.5	5 18;	10 13;	20 3;	29 18		
W Gemin.	29.2	+15 24	6.8— 7.6	7 22.0	2 23;	10 21;	18 19;	26 17		
ζ Gemin.	6 58.2	+20 43	3.7— 4.5	10 03.7	11 3;	21 6				
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	6 9;	28 16				
RR Gemin.	7 15.2	+31 04	9.7—10.6	0 09.5	4 13;	12 11;	20 10;	28 9		
V Carinæ	8 26.7	−59 47	7.2— 8.0	6 16.7	6 8;	13 1;	19 18;	26 10		
T Velorum	8 34.4	−47 01	7.5— 8.5	4 15.3	1 9;	6 0;	15 7;	24 14		
W Carinæ	9 19.2	−55 32	7.5— 8.5	4 08.9	4 15;	9 0;	17 17;	26 11		
S Antliæ*	27.9	−28 11	6.7— 7.8	0 07.8	1 1;	7 13;	14 0;	27 0		
W Ursæ Maj.	9 36.7	+56 24	8.	0 04.0	5 12;	12 4;	18 20;	25 12		
RR Leonis	10 02.1	+24 03	9.1—10.0	0 10.9	3 14;	8 8;	17 20;	7 7		
ST Ursæ Maj.*	11 22.4	+45 44	6.7— 7.2	8 19.2	9 5;	18 0;	26 19			
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6 15;	13 6;	19 20;	26 11		
S Muscae	12 07.4	−69 36	6.5— 7.3	9 15.8	5 20;	15 12;	25 3			
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	5 11;	11 4;	22 13;	28 6		
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	6 22;	13 16;	20 10;	27 3		
R Crucis	18.1	−61 04	6.8— 8.0	5 19.8	3 14;	9 9;	21 1;	26 21		
S Crucis	48.4	−57 53	6.6— 7.8	4 16.6	5 3;	9 19;	19 5;	28 14		
RZ Centauri	12 55.6	−64 05	8.5— 8.9	0 22.5	6 16;	14 4;	21 16;	29 4		
W Virginis	13 20.9	− 2 52	9.0—10.0	17 06.5	13 7;	30 14;	7 23;	14 23		
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	22 0;	29 0				
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	4 7;	12 12;	20 17;	28 22		
V Centauri	25.4	−56 27	6.7— 7.6	5 11.9	4 20;	10 8;	21 8;	26 20		
RS Bootis	29.3	+32 11	8.9—10.	0 09.1	8);	15 14;	23 3;	30 16		
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	4 12;	11 22;	19 7;	26 18		
R Triang. Austr	15 10.8	−66 08	6.7— 7.7	3 09.3	5 12;	12 7;	19 2;	25 20		
ST Triang. Austr	15 52.2	−63 29	6.5— 7.5	6 07.8	1 20;	8 4;	20 19;	27 3		
S Normæ	16 10.6	−57 39	6.5— 7.4	9 18.1	3 16;	13 10;	23 4			
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	3 13;	12 10;	21 7;	30 3		
RV Scorpii	16 51.8	−33 27	6.8— 7.6	6 01.5	5 3;	11 4;	23 7;	29 9		
u Herculis*	17 13.6	+33 12	5.1— 5.6	2 01.2	2 8;	8 12;	20 19;	26 23		
RV Ophiuchi*	17 29.8	+ 7 19	9.—< 11	3 16.5	2 9;	9 18;	17 3;	24 12		
X Sagittarii	41.3	−27 48	4.0— 6.0	7 00.3	3 20;	10 20;	17 21;	24 21		
Y Ophiuchi	47.3	− 6 07	6.2— 7.0	17 02.9	13 0;	30 2				
W Sagittarii	17 58.6	−29 35	4.8— 5.8	7 14.3	2 11;	10 1;	17 16;	25 6		
Y Sagittarii	18 15.5	−18 54	5.8— 6.6	5 18.6	5 18;	11 12;	23 2;	28 20		
U Sagittarii	26.0	−19 12	7.0— 8.3	6 17.9	3 9;	10 3;	23 14;	30 8		
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	4 2;	14 10;	24 19			
Y Lyrae	34.2	+43 52	10.5—12.	0 12.1	4 10;	10 11;	22 12;	28 13		
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	6 2;	11 5;	21 10;	26 13		
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	4 15;	9 14;	19 12;	29 10		
β Lyrae *	46.4	+33 15	3.4— 4.5	12 21.8	1 2;	14 0;	26 22			
κ Pavonis	18 46.9	−67 22	4.0— 5.5	9 02.2	4 13;	13 16;	22 18			

Maxima of Variable Stars of Short Period not of the Algol Type.

Continued.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in November 1912. d h	d h	d h	d h
U Aquilae	19 24.0	— 7 15	6.4— 7.1	7 00.6	1 18;	8 18;	22 20;	29 20
XZ Cygni	30.4	+56 10	8.7— 9.3	0 11.2	4 6;	8 22;	18 6;	27 14
U Vulpec.	32.2	+20 07	6.9— 7.6	7 23.5	7 11;	5 11;	23 10	
SU Cygni	40.8	+29 01	6.6— 7.4	3 20.3	2 18;	10 10;	18 3;	25 20
η Aquilae	47.4	+ 0 45	3.5— 4.7	7 04.2	7 8;	14 12;	21 16;	28 21
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	6 22;	15 7;	23 17	
X Vulpec.	19 53.3	+26 17	8.5— 9.1	6 07.7	6 16;	12 23;	19 7;	25 15
XX Cygni	20 01.3	+58 40	10.5—11.5	0 03.2	1 5;	7 22;	21 10;	28 4
V Vulpec. *	32.3	+26 15	8.0— 9.0	37 19.0		29 22;		
X Cygni	20 39.5	+35 14	6.4— 7.7	16 09 3	3 21;	20 6		
T Vulpec.	47.2	+27 52	5.5— 6.5	4 10 5	2 18;	7 4;	16 1;	24 22
WZ Cygni *	49.3	+38 27	9.8—10.8	0 14.0	4 15;	10 11;	22 4;	28 0
WY Cygni	52.3	+30 03	9.5—10.3	0 13.5	1 17;	7 8;	18 13;	29 18
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	3 16;	8 4;	17 3;	26 1
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	1 8;	16 1		
VY Cygni	21 00.4	+39 34	8.9— 9.5	7 20.6	4 3;	12 0;	19 20;	27 17
VZ Cygni	21 47.7	+42 40	8.4— 9.2	4 20.7	5 13;	10 10;	20 3;	29 21
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.6	2 6;	10 22;	19 13;	28 5
δ Cephei	25.5	+57 54	3.7— 4.9	5 08.8	1 12;	6 21;	17 15;	28 8
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	8 18;	19 15;	30 12	
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	4 1;	10 11;	23 7;	29 17
V Lacertae	44.5	+55 48	8.2— 8.9	4 23.6	4 4;	9 4;	19 3;	29 2
X Lacertae *	22 45.0	+55 54	8.2— 8.6	5 10.6	2 11;	7 22;	18 19;	29 16
SW Cassiop.	23 03.7	+58 12	9.2— 9.7	5 10.6	3 21;	9 8;	20 4;	25 15
RS Cassiop.	32.6	+61 52	9.1—10.0	6 07.1	5 18;	12 1;	24 15;	30 22
RY Cassiop.	47.2	+58 11	9.2—10.0	12 03.4	3 6;	15 9;	27 13	
U Pegasi	23 52.9	+15 24	9.0— 9.7	0 04.5	4 14;	12 2;	19 13;	27 1

The following notes on recently discovered variable stars are given by S. Enebo in *A. N.* 4595.

120.1907 Draconis. This star belongs to the Algol type. Approximate elements of this star are:

Minimum = 2419429.28 G.M.T. + $1^d.6306$ E

The range is from $9^m.0$ to $9^m.8$.

134.1907 Pegasi. According to observations extending over a period of nearly five years it was found that the range of variability of this star extends from $9^m.0$ to $9^m.7$ in an apparently irregular period. The curve indicates unequal minima, and therefore the star does not fit exactly into either the RV Tauri or β Lyrae type.

AV (35.1910) Cygni. The light of this star varies between the limits $11^m.5$ and $12^m.5$. Maxima were observed on Oct. 15, 1910 Dec. 26, 1910 and Sept. 29, 1911. The period is probably about 70 days.

6.1911 Trianguli. From Sept. 1911 to March 1912,33 observations of this star were made. Most of these show the star at minimum, about 12.5 or 13.0 magnitude. In four of them the star was near its maximum, approximately 11.5 magnitude. On Jan. 15, 1912, a rapid rise was noticed. The probability is that it is of the ant-Algol type. The observations of the maxima are nevertheless too few to establish a definite period.

TX (13.1911) Persei. Two maxima, about 9.9 magnitude, and two minima, about 11.1 magnitude have been observed. The following formula gives the times of maxima. Maxima = 2419484 + 121^d E.

18.1911. This star at the middle of January 1912 was approximately of the 8.5 magnitude, the middle of February about 9.0 magnitude and on April 17 of magnitude 8.1. Long period very probable.

Nova Geminorum No. 2.—In the *Harvard Astronomical Bulletin* No. 496 Professor E. C. Pickering says: "From an examination of a photograph of Nova Geminorum No. 2, taken with the 8-inch Draper telescope on Sept. 10, 1912 Miss Cannon finds that the bands 4959 and 5007 are present and of about the same relative intensity as in the gaseous nebula + 50°2869. A bright band which appears to be the nebular band 4364 is also well marked, and more intense than Hγ."

COMET AND ASTEROID NOTES.

New Comet 1912 a.—A cablegram from Kiel, Germany to Harvard College Observatory on Sept. 11 announced the discovery of a new comet by Gale of Sydney, Australia, on Sept. 8. The position as given in the list of observations below, places the comet in the constellation Centaurus, invisible at this time of the year in the United States. Its motion, as shown by the later observations, is northeastward and it ought to become visible to northern observers early in October. Its course during September, according to the ephemeris given below, has been through Centaurus, Hydra and Libra, and during October it is likely to pass through Serpens into Hercules. The comet was visible to the naked eye on Sept. 11 and should be equally bright or brighter in October.

The following observations are all that have come to hand at this writing (Sept. 23):

Date Gr.M.T.	α h m s	δ ° ′ ″	Observer	Place
1912 Sept. 8.8889	13 37 00.1	−36 31 02	Gale	Sydney
11.5222	13 54 02.4	−33 10 50	Prager	Santiago
15.2359	14 15 28.7	−28 11 13	—	Cape of Good Hope
17.4524	14 26 58.5	−25 06 18	Hussey	Buenos Ayres

The following elements from *Harvard Astronomical Bulletin* No. 497, were computed by Dr. Ebell from observations on Sept. 8, 11 and 15.

$T = 1912$ Oct. 4.67
$\omega = 24° 18'$
$\Omega = 295\ 18$
$i = 82\ 07$
$q = 0.727$

EPHEMERIS OF COMET 1912 a.

Gr.M.T.	R.A. h m s	Dec. ° ′	Light
Sept. 19.5	14 36 40	−22 14	1.23
23.5	14 53 24	16 39	
27.5	15 07 26	11 12	
Oct. 1.5	15 19 04	− 6 00	1.21

Minor Planet 1911 MT.—In the *Lick Observatory Bulletin* No. 216, Mr. E. S. Haynes of the Berkeley Astronomical Department gives new elements of the planet 1911 MT based upon eight observations on the dates Oct. 3, 4, 11 and 17. All the observations are quite well represented. The period comes

out 4.1148 years and the eccentricity 0.538, so that the orbit is more like that of one of the Jupiter family of comets than that of an asteroid. The accompanying diagram is drawn using Mr. Haynes' elements of MT, and shows the relative positions of the orbits of Earth, Mars, Eros and 1911 MT. It will be noticed that MT does not approach the earth's orbit quite so close as does Eros but that it goes much farther out through the asteroid zone.

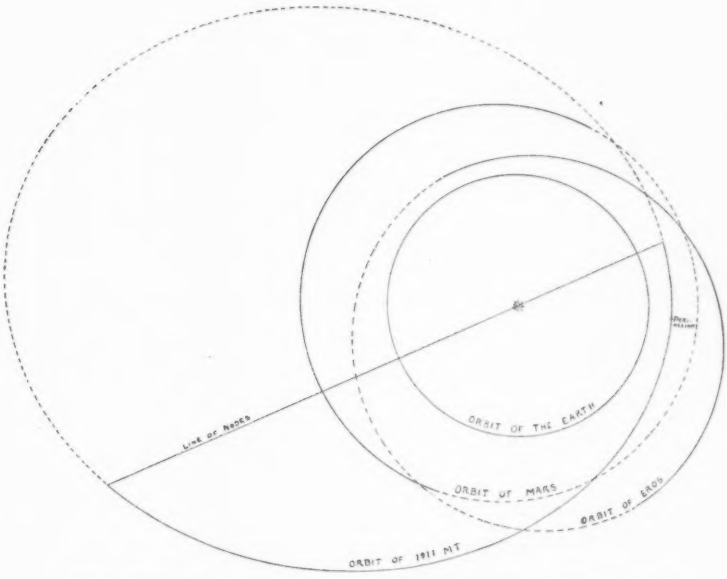


DIAGRAM SHOWING THE ORBITS OF EARTH, Mars, Eros and 1911 MT.

Mr. L. v. Tolnay, of Budapest, has also published new elements of MT (*A.N.* 4593) which agree closely with those of Mr. Haynes. The two sets of elements are given below for comparison.

	Haynes	Tolnay	
T =	1911 Aug. 28.9286 Gr. M. T.	Aug. 28.9127 Berlin M.T	
ω	151° 46′ 07″	151° 43′ 07″	1911.0
Ω	185 32 59	185 33 10	
i	10 47 28	10 50 24	
e	0.538228	0.541735	
a	2.56784	2.58900	
μ	862″.298	851″.748	
Period	4.1148 years	4.1659 years	

Two more photographic images of the planet have been found, one on a plate taken at Heidelberg Sept. 16 and another on a plate obtained at Johannesburg Oct. 18, 1911. It thus appears that the orbit may finally be quite well determined.

In *The Observatory*, Sept. 1912, Mr. A. C. D. Crommelin points out the resemblance between the orbit of MT and that of planet 1908 DW, discovered by Dr. Palisa 1908, Sept. 21, and observed on eight nights extending to Oct. 5. The following elements by Dr. Palisa are given in the *Berlin Jahrbuch* 1913:—

$T = 1908$ June 27.7 Berlin M.T.
$\omega = 129° 26' 55''$
$\Omega = 178\ 11\ 34$ } 1908.0
$i = 6\ 17\ 23$
$e = 0.4575$
$\mu = 818''.534$
$a = 2.659$
Period $= 4.3345$ years

Mr. Crommelin does not think the identity of the two bodies possible, but that they belong to the same group of planets.

Ephemeris of Holmes' Comet.

[From Astronomische Nachrichten 4594.]

1912	α			δ			log Δ	Br.
	h	m	s	°	′	″		
Oct. 1	18	51	44.96	− 33	12	41.9	0.300324	0.0483
5		56	49.62		32	23	47.3	0.308098	0.0470
9	19	2	12.10		31	35	4.0	0.315817	0.0458
13		7	50.95		30	46	26.7	0.323455	0.0446
17		13	44.73		29	57	49.5	0.330986	0.0434
21		19	51.95		29	9	5.6	0.338397	0 0423
25		26	11.28		28	20	10.3	0.345672	0.0412
29		32	41.57		27	30	56.3	0.352807	0.0402
Nov. 2		39	21.75		26	41	18.4	0.359795	0.0392
6		46	11.01		25	51	11.4	0.366626	0.0383
10	19	53	8.41		25	0	30.1	0.373294	0.0374
14	20	0	13.14		24	9	10.4	0.379789	0.0365
18		7	24.20		23	17	7.6	0.386107	0.0357
22		14	40.78		22	24	20.0	0.392245	0.0349
26		22	2.13		21	30	43.8	0.398206	0.0342
30		29	27.67		20	36	17.1	0.403990	0.0334
Dec. 4		36	56.98		19	40	57.7	0.409600	0.0327
8		44	29 53		18	44	43.6	0.415029	0.0321
12		52	4.87		17	47	33.6	0.420278	0.0314
16	20	59	42 42		16	49	27.9	0.425342	0.0308
20	21	7	21.77		15	50	26.8	0.430229	0.0302
24		15	2.38		14	50	30.9	0.434937	0.0297
28		22	44.16		13	49	41.0	0.439474	0.0291
32	21	30	26.86	− 12	47	58.2	0.443842	0.0286

NOTES FOR OBSERVERS.

The Monthly Report of the American Association of Variable Star Observers. July, Aug., and Sept.—This report contains over twelve hundred observations of 81 variable stars, the result of eleven weeks work on the part of twelve observers. It is a report that the Association may well be proud of, and the data included form beyond question a valuable contribution to the science of Astrophysics. A perusal of the observations will at

VARIABLE STAR OBSERVATIONS July to Sept., 1912.

001755
T Cassiopeiae

Mo.	Day	Est.	Obs.
7	2	8.7	L
	6	8.0	Ba
	12	7.8	B
	14	8.3	Ba
	14	8.7	J
	15	8.5	L
	18	8.6	C
	23	8.0	B
	25	8.7	J
	26	8.7	L
	27	8.8	J
8	2	8.6	C
	5	8.7	J
	5	8.6	L
	7	8.6	C
	8	7.9	B
	10	8.6	C
	12	8.7	J
	13	8.6	Ha
	15	8.0	B
	16	8.7	J
	16	7.9	O
	17	8.7	L
	21	8.0	G
	22	7.9	G
	24	8.5	L
	24	7.8	G
	25	7.9	G
	27	8.1	B
	29	8.0	G
	29	8.3	J
	31	8.8	Ha
9	6	7.7	B
	8	8.6	O
	8	8.5	J

001726
T Androm.

Mo.	Day	Est.	Obs.
9	6	9.2	O
	9	9.1	O

004958
W Cassiopeiae

Mo.	Day	Est.	Obs.
7	14	11.7	J
	26	11.9	J
8	15	12.2	J
9	8	12.3	J

011208
S Piscium

Mo.	Day	Est.	Obs.
9	8	9.6	O

013238
RU Androm.

Mo.	Day	Est.	Obs.
7	28	9.6	J
8	5	9.6	J
	16	10.5	J
9	8	11.8	J

013338
Y Androm.

Mo.	Day	Est.	Obs.
9	8	11.2	J

014958
X Cassiopeiae

Mo.	Day	Est.	Obs.
8	17	11.3	L
	24	11.0	L

021024
R Arietis

Mo.	Day	Est.	Obs.
9	8	8.5	O

021258
T Persei

Mo.	Day	Est.	Obs.
7	19	8.7	C
	21	8.7	C
8	7	9.1	C
	10	9.3	C
	16	9.5	B
	21	9.2	C
	27	8.7	B

021403
o Ceti

Mo.	Day	Est.	Obs.
7	10	5.0	F
	12	5.1	L
	16	5.3	F
	16	5.0	G
	18	5.2	L
	20	5.7	F
	21	5.6	L
	21	5.5	G
	23	5.5	G
	30	5.2	L
8	1	5.4	L
	8	5.7	L
	10	6.4	C
	10	5.9	L
	11	6.0	F
	13	5.8	L
	17	6.2	F
	17	6.4	L
	21	6.4	C
	22	6.0	G
	23	6.3	L
	23	5.9	G

021658
S Persei

Mo.	Day	Est.	Obs.
8	16	10.4	B
	27	9.6	B

022813
U Ceti

Mo.	Day	Est.	Obs.
8	10	7.3	C
	21	7.6	C

024356
W Persei

Mo.	Day	Est.	Obs.
8	16	10.2	O
9	9	9.9	O

043274
X Camelop.

Mo.	Day	Est.	Obs.
9	8	8.8	O

045514
R Leporis

Mo.	Day	Est.	Obs.
8	11	8.4	F
	18	8.6	L
	23	8.4	G
	25	8.5	G

050953
R Aurigae

Mo.	Day	Est.	Obs.
7	28	10.4	J
8	16	10.0	J
	29	9.5	J
9	8	9.1	J

054920
U Orionis

Mo.	Day	Est.	Obs.
8	11	8.4	F
	25	8.8	G

094211
R Leonis

Mo.	Day	Est.	Obs.
7	3	6.1	G

103769
R Urs. Maj.

Mo.	Day	Est.	Obs.
7	13	11.7	Ha
	14	11.0	F
	30	11.5	Ha
8	3	11.0	Ha
	11	10.6	Ha
	12	10.7	J
	16	10.2	J
	16	10.1	L
	16	9.8	B
	17	10.1	Ha
	17	10.5	F
	18	9.6	L
	19	9.4	L
	22	9.2	M
	23	9.5	Ha
	24	9.0	J
	24	9.0	L
	26	8.8	L
	27	8.5	B
	29	8.4	M
	29	8.5	J
	30	8.6	Ha
9	2	8.1	M
	3	8.2	F
	4	8 2	Ha
	6	7.9	B
	8	7.9	J

122001
SS Virginis

Mo.	Day	Est.	Obs.
7	4	7.0	G

122532
T Can. Ven.

Mo.	Day	Est.	Obs.
7	1	9.6	V

123160
T Urs. Maj.

Mo.	Day	Est.	Obs.
7	19	12.6	Hu

123961
S Urs. Maj.

Mo.	Day	Est.	Obs.
6	30	8.7	L
7	1	8.3	V
	3	8.7	G
	4	8.5	G
	5	8.6	V
	5	8.7	L
	6	8.6	M
	7	8.4	G
	8	8.9	J
	8	8.9	C
	8	8.7	M
	8	8.7	Ba
	9	8.7	M
	9	8.9	J
	9	8.4	G
	10	8.4	M
	11	8.5	V
	11	8.6	G
	12	8.6	G
	12	8.8	M
	12	8.9	C
	13	8.9	Ha
	13	8.9	C
	13	9.1	J
	13	9.0	Ba
	14	9.1	J
	14	9.0	F
	14	8.9	M
	15	8.8	G
	15	9.1	L
	16	9.0	C
	16	8.7	B
	16	9.2	M
	17	8.9	G
	18	8.8	V
	18	9.1	Ha
	18	9.2	L
	18	9.1	C
	19	8.8	Hu
	20	8.9	G
	21	9.2	Ha
	22	9.0	G
	23	9.1	B
	23	9.8	F
	24	9.2	O
	24	9.4	L
	24	9.0	G
	25	9.2	G
	26	9.7	M
	26	9.5	G
	26	9.6	J
	27	9.5	J
	27	9.7	G
	28	9.5	Ha
	29	10.0	M

S Urs. Maj.

Mo.	Day	Est.	Obs.
7	29	9.7	J
	29	9.6	Ha
	30	9.7	J
	30	9.6	G
	30	9.2	F
	30	9.2	C
	31	9.2	C
8	1	10.0	F
	1	10.4	M
	1	9.7	G
	2	9.7	C
	3	9.9	V
	3	10.0	Ha
	3	10.0	O
	3	9.8	G
	3	10.1	B
	4	10.0	J
	4	9.8	G
	4	10.1	C
	5	10.0	J
	5	10.1	L
	5	9.8	G
	6	10.0	J
	6	11.0	C
	7	10.8	C
	9	10.8	F
	9	10.9	L
	11	10.6	Ha
	12	10.3	J
	12	10.4	B
	12	11.0	M
	13	11.1	M
	13	11.0	C
	14	10.2	G
	16	10.5	J
	16	10.6	G
	17	10.9	Ha
	21	11.1	G
	23	11.2	Ha
	30	11.3	B
9	4	—	Ha
	6	11.7	B
	8	11.3	J

132422

Mo.	Day	Est.	Obs.
7	4	9.5	G
	7	9.7	G
	12	9.3	C
	12	9.8	G
	14	9.7	F

134440
R Can. Ven.

Mo.	Day	Est.	Obs.
7	2	7.7	L
	5	7.7	L
	6	7.2	M
	7	7.3	Ba
	7	7.3	M
	8	7.1	Ha
	8	8.0	C

VARIABLE STAR OBSERVATIONS July to Sept. 1912—Continued.

R Can. Ven.

Mo.	Day	Est.	Obs.
7	9	7.6	M
	12	7.7	C
	13	7.7	Ba
	15	7.8	L
	16	7.8	C
	18	7.9	C
	18	7.9	L
	24	7.9	L
	29	8.1	M
	31	8.5	L
8	2	8.3	C
	3	8.5	O
	3	8.4	C
	4	8.6	L
	6	8.4	C
	7	8.6	C
	9	8.6	L
	12	8.7	L
	13	8.5	C
	13	9.6	Ha
	19	8.8	L
	23	9.0	L
	29	9.0	O

141567

U Urs. Min.

7	8	8.7	Ba
	13	9.0	J
	27	9.3	J
8	4	9.6	J
	12	9.7	J
	16	9.8	J
	24	10.1	J
	27	10.3	J
9	8	10.5	J

141954

S Boötis

7	24	8.1	Hu
8	15	11.8	B
	16	11.6	O
	16	11.2	J
9	8	9.8	O

142205

RS Virginis

6	30	9.0	L
7	4	9.0	L
	8	9.0	L
	13	8.8	L

142539

V Boötis

7	2	9.0	L
	3	8.8	G
	5	9.7	V
	6	9.5	V
	7	9.0	G
	13	10.8	L
	17	10.1	V
	19	10.1	B
	20	10.0	G

V Bootis

Mo.	Day	Est.	Obs.
7	22	10.8	L
	27	10.0	B
	31	11.0	G
8	1	11.0	G
	3	10.8	V
	5	11.3	O
	5	10.9	L
	12	11.4	L
	15	11.0	B
	30	10.4	B

142584

R Camelop

6	30	9.3	L
7	6	9.1	Ba
	9	9.1	L
	13	8.9	J
	13	8.7	B
	14	8.7	Ba
	15	9.0	L
	18	9.0	L
	19	9.0	O
	23	8.6	B
	24	8.9	L
	27	8.9	J
	30	8.8	O
	31	8.7	L
8	1	8.7	O
	1	8.7	G
	2	8.6	B
	4	8.8	J
	4	8.7	O
	4	8.6	L
	5	8.6	B
	9	8.7	L
	13	8.7	O
	16	8.5	O
	16	8.8	L
	16	8.9	J
	17	8.7	G
	20	8.5	B
	22	8.3	G
	24	8.8	L
	25	8.2	G
	27	8.5	B
	29	8.8	J
	29	8.4	O
	31	8.4	G
9	6	8.4	O
	6	8.3	B
	8	8.6	J
	9	8.4	O

143227

R Boötis

8	15	11.5	B
	30	10.1	B
9	9	9.5	O

151731

S Cor. Bor.

7	7	10.8	Ba
	13	11.3	Ba
9	8	10.5	O

153378

S Urs. Min.

Mo.	Day	Est.	Obs.
7	5	10.8	L
	13	10.3	L
	17	10.2	L
	24	10.0	L
	31	9.6	L
8	4	9.6	L
	9	9.3	L
	16	9.3	L
	19	9.3	L
	24	9.3	L

154428

R Cor. Bor.

6	30	7.0	L
7	4	7.0	G
	4	7.0	L
	6	7.0	Ba
	6	7.0	L
	7	7.0	M
	7	7.1	Ba
	8	7.2	L
	8	7.0	C
	8	7.0	Ba
	8	7.1	G
	9	7.1	M
	12	6.8	C
	12	7.0	G
	13	6.4	Ha
	13	6.5	J
	13	6.7	C
	13	6.8	Ba
	14	6.4	J
	15	6.9	G
	15	7.1	L
	16	7.2	M
	16	6.6	C
	17	7.0	L
	17	6.9	G
	18	6.8	C
	19	6.8	Hu
	21	6.1	Ha
	21	6.8	C
	22	6.7	L
	23	7.0	F
	24	6.9	L
	26	7.1	M
	27	6.8	G
	27	6.5	J
	28	5.8	Ha
	29	6.2	M
	30	6.6	G
	30	6.8	F
	30	6.3	J
	30	6.7	O
	30	6.7	C
	31	6.8	C
	31	6.7	L
8	1	6.4	J
	1	6.7	F
	1	6.5	G
	2	6.8	C

R Cor. Bor.

Mo.	Day	Est.	Obs.
8	3	6.8	O
	3	6.0	Ha
	3	6.7	L
	3	6.6	C
	4	6.3	J
	4	6.5	M
	4	6.2	G
	4	6.8	L
	4	6.6	C
	5	6.4	J
	5	6.8	F
	5	6.7	L
	5	6.1	G
	6	6.4	M
	6	6.3	J
	6	6.6	C
	7	6.3	J
	7	6.0	G
	7	6.5	C
	8	6.6	L
	9	6.6	L
	11	6.8	F
	11	6.6	C
	11	6.7	M
	12	6.6	L
	12	6.3	J
	13	6.2	Ha
	13	6.8	O
	13	6.7	C
	14	6.7	F
	16	6.6	L
	16	6.7	O
	16	6.0	G
	16	7.2	Bu
	16	6.1	J
	17	6.5	F
	17	5.8	G
	19	5.8	G
	20	6.8	Bu
	22	5.6	G
	23	6.5	L
	23	6.0	G
	24	5.9	G
	24	6.4	L
	25	6.4	F
	25	6.6	J
	25	5.9	G
	26	6.6	L
	29	6.2	G
	29	6.5	O
	29	6.3	J
	30	6.8	Bu
	31	6.4	Ha
	31	6.5	Bu
	31	6.6	G
9	1	6.8	G
	2	6.2	M
	3	6.2	F
	4	6.5	Ha
	4	6.8	Bu
	6	6.5	O

R.Cor Bor.

Mo.	Day	Est.	Obs.
9	8	6.1	O
	9	6.2	O

154536

X Cor. Bor.

7	13	9.3	J
	26	9.3	J
	27	9.0	J
8	4	9.1	J
	6	9.2	J
	12	9.3	J
	16	9.6	J
	24	9.8	J
	29	10.1	J
9	8	11.0	J

154615

R Serpentis

7	8	7.6	C
	11	6.0	G
	12	7.6	C
	13	8.0	C
	16	7.9	C
	18	8.1	C
	21	8.4	C
	31	8.5	C
8	1	8.5	O
	2	8.4	C
	3	8.5	C
	6	8.5	C
	7	8.7	C
	11	8.7	C
	13	8.9	C
	13	8.9	O
	29	9.8	O
	31	8.0	G
9	1	8.0	G
9	9	9.9	O

155823

RZ Scorpii

7	3	7.8	G
	9	7.6	G
	17	7.6	G
	20	7.7	G
	30	9.8	F
8	3	8.2	G
	17	8.9	G
	30	9.1	G

155847

X Herculis

7	6	6.3	L
	15	6.4	L
	21	6.4	L
	31	6.1	L
8	9	6.3	L
	16	6.2	L
	24	6.1	L

160625

RU Herculis

8	13	9.4	O
	29	8.9	O
9	8	9.4	O

VARIABLE STAR OBSERVATIONS July to Sept. 1912.—Continued.

161138
W Cor.Bor.

Mo.	Day	Est.	Obs.
7	7	11.6	Ba
	13	11.4	Ba

162119
U Herculis

	4	11.3	B

163172
R Urs. Min.

7	16	9.9	B
8	1	9.2	B
	16	9.6	O
	20	9.1	B
	29	8.9	B
9	8	9.4	O

163266
R Draconis

7	6	12.2	Ba
8	12	11.6	J
	31	12.2	B

164715
S Herculis

7	8	11.8	Ba
8	5	11.4	J
	12	11 0	J
	16	11.0	J
	29	10.2	J
9	9	10.5	O

165631
RV Herculis

7	7	11.6	Ba
8	24	12.2	M
9	6	10.5	O

170215
R Ophiuchi

7	8	12.5	B
8	3	13.0	M
	17	12.6	M

171401
Z Ophiuchi

7	8	7.8	V
9	9	9.0	O

175458
T Draconis

7	17	10.7	V
8	1	9.5	G
	3	10.8	V

180531
T Herculis

7	5	8.6	G
	6	9.0	L
	6	8.9	M
	7	8.9	M
	8	9.3	Ba
	8	8.9	V
	8	9.2	M

T Herculis

Mo.	Day	Est.	Obs.
7	8	8.9	C
	9	9.2	M
	11	8.6	G
	12	8.9	C
	14	9.4	L
	16	9.0	C
	16	9.5	L
	16	9.3	M
	17	8.9	G
	17	9.0	V
	18	9.2	C
	18	9.6	L
	20	9.2	G
	21	9.4	C
	22	9.6	L
	26	9.8	G
	26	9.9	L
	31	9.6	C
	31	10.6	L
8	1	10.4	M
	2	9.7	C
	3	10.7	V
	3	9.7	C
	4	10.3	Ha
	5	11.1	L
	6	9.8	C
	7	9.9	C
	10	10.0	C
	13	10.0	C
	13	10.5	M
	16	11.4	L

181136
W Lyrae

7	1	10.0	Hu
	3	8.7	G
	8	9.7	C
	8	9.2	Ba
	12	9.8	C
	16	9.4	G
	18	9.8	C
	19	9.5	G
	21	9.8	C
8	3	10.4	C
	7	10.6	C

184205
R Scuti

7	3	5.9	G
	8	5.7	C
	9	5.5	F
	11	5.8	G
	12	5.7	C
	13	5.9	G
	13	5.6	Ha
	13	5.6	C
	14	5.8	G
	16	5.5	C
	16	5.8	G
	18	5.5	C
	20	5.7	G
	21	5.8	Ha
	21	5.7	C

R Scuti

Mo.	Day	Est.	Obs.
7	23	5.4	F
	29	5.9	Ha
	30	6.1	G
	30	5.7	F
	31	5.8	C
8	1	6.1	G
	1	5.7	F
	2	5.9	C
	3	6.0	Ha
	3	6.1	G
	3	5.8	C
	3	5.5	L
	4	5.8	O
	4	5.7	C
	5	6 2	G
	5	5.9	L
	6	5.7	C
	7	5.8	C
	8	6.0	L
	9	6.0	L
	10	5.9	C
	11	5.6	M
	11	5.8	C
	11	5.8	F
	12	5.7	L
	13	5.8	C
	13	6.0	Ha
	14	6.1	G
	16	5.8	L
	16	6.0	G
	16	5.8	B
	17	5.8	F
	17	6.0	Ha
	19	5.7	L
	20	6.1	G
	21	5.1	M
	22	5.1	M
	23	5.6	L
	25	6.1	G
	26	5.5	L
	29	6.0	G
	29	4.9	M
	30	5.8	Ha
	31	6.3	Bu
9	2	4.8	M
	3	5.5	F
	4	6.5	Bu
	9	5.1	O

191119
R Sagittarii

8	7	8.8	G

191350
TZ Cygni

8	17	10.6	L

193732
TT Cygni

8	3	8.5	G
	11	7.8	F
	20	9.0	G
	29	9.7	G

194048
RT Cygni

Mo.	Day	Est.	Obs.
7	7	10.0	Ba
	9	9.8	F
	16	9.8	L
	21	9.5	L
	24	8.8	Hu
	24	9.3	L
	30	8.6	F
	31	8.7	L
	31	8.4	C
8	1	8.6	F
	4	8.7	L
	5	8.5	F
	8	8.5	L
	8	8.4	M
	9	8.5	F
	13	8.4	L
	13	8.0	C
	17	8.3	F
	17	8.4	L
	21	8.0	M
	22	8.0	M
	24	8.3	L
	25	8.2	G
	29	8.0	F
	29	8.1	G
	31	7.9	G
9	1	7.9	G
	2	7.8	M
	3	8.0	F

194348
TU Cygni

8	29	10.0	G

194632
X Cygni

7	1	9.8	Hu
	7	10.4	Ba
	8	10.5	Ha
	10	10.0	B
	13	10.2	J
	15	10.2	G
	22	10.8	M
	22	9.8	G
	24	9.8	G
	24	9.6	Hu
	26	10.1	J
	27	10.0	J
	29	10.0	Ha
	30	9.6	G
8	1	10.0	F
	2	9.5	G
	3	9.9	Ha
	4	10.2	O
	4	9.6	J
	7	10.0	M
	8	9.5	B
	8	9.8	M
	9	9.5	F
	11	9.7	Ha
	11	9.8	M
	12	9.5	J

X Cygni

Mo.	Day	Est.	Obs.
8	16	8.9	J
	16	9.5	G
	17	9.3	F
	17	9.4	Ha
	19	9.2	Ha
	22	8.2	M
	24	7.4	J
	25	7.2	Ha
	29	6.3	F
	29	8.9	G
	29	5.5	B
	29	6.5	J
	30	6.4	Ha
	31	6.0	O
	31	8.8	G
9	1	8.9	G
	3	6.0	F
	4	5.9	Ha
	5	5.6	M
	6	5.0	B
	6	5.5	O
	6	5.5	Ha
	8	5.4	O
	8	5.2	J
	9	5.4	O

195849
Z Cygni

7	24	9.0	G
8	30	10.3	G

200647
SV Cygni

7	5	8.0	G
	7	8.0	G
	9	9.0	F
	22	8.2	G
	24	8.3	G
	26	8.2	G
	30	8.2	F
8	1	9.0	F
	1	9.0	G
	3	8.8	G
	4	8.2	F
	5	8.5	G
	9	8.9	F
	14	8.8	G
	17	9 3	F
	19	8.6	G
	21	8.9	C
	22	8.6	M
	29	9.3	F
	29	9.1	G
9	2	8.7	M
	3	9.2	F

200715
S Aquilae

8	1	11.2	F
	4	11.1	G
	11	11.0	F
	12	10.2	M
	17	9.5	G
	17	10.1	F

VARIABLE STAR OBSERVATIONS to July, to Sept., 1912.—Con.

200716
R Sagittae

Mo.	Day	Est.	Obs.
8	1	9.3	F
	4	9.1	G
	11	9.5	F
	17	9.0	G
	17	9.3	F
	21	8.8	G
	25	8.8	F
	31	8.5	G

200715
RW Aquilae

Mo.	Day	Est.	Obs.
8	1	9.2	F
	11	9.0	F
	17	9.0	F
	25	9.0	F

200938
RS Cygni

Mo.	Day	Est.	Obs.
7	3	7.8	G
	11	7.3	G
	13	8.2	J
	23	7.0	G
	26	6.9	G
	27	8.3	J
	28	6.8	G
	30	7.2	F
	31	6 8	G
8	1	7.3	F
	2	6.9	G
	3	7.2	O
	4	8.2	J
	9	7.2	F
	14	6.9	G
	16	8.3	F
	16	7.0	G
	17	7.5	F
	18	7.0	G
	19	7.4	Ha
	20	6.9	G
	23	7.1	G
	24	7.4	J
	25	7.1	G
	25	7.2	Ha
	29	7.1	F
	29	7.2	G
	31	7.2	Ha
9	3	7.2	F
	8	8.0	J

201008
R Delphini

Mo.	Day	Est.	Obs.
7	7	11.6	Ba
	19	11.5	B
8	5	12.3	B

201647
U Cygni

Mo.	Day	Est.	Obs.
6	30	9.1	L
7	3	7.9	G
	5	7.9	G

U Cygni

Mo.	Day	Est.	Obs.
7	7	8.0	G
	8	8.4	C
	9	8.5	F
	11	8.0	G
	13	9.1	J
	17	8.1	G
	17	9.8	L
	23	8.1	F
	24	8.8	O
	24	8.2	G
	26	8.2	G
	27	9.4	J
	30	8.8	F
	31	8.3	G
8	1	9.2	F
	3	8.5	G
	4	9.6	J
	5	8.5	G
	8	9.8	L
	9	8.4	F
	14	8.6	G
	16	9.8	J
	17	8.6	G
	17	9.0	F
	20	9.0	G
	23	9.0	G
	26	10.4	L
	27	9.7	J
	28	9.2	G
	29	9.2	G
9	3	9.5	F
	3	9.3	G
	8	10.2	J

202846
TV Cygni

Mo.	Day	Est.	Obs.
8	13	13.1	L
	26	9.7	L

202946
SZ Cygni

Mo.	Day	Est.	Obs.
7	12	10.0	G
	17	8.8	G
	19	8.9	G
	20	9.0	G
	21	9.2	G
	21	10.0	F
	22	9.5	G
	23	9.7	F
	23	9.5	G
	24	9.6	G
	25	9.8	G
	26	9.8	G
	27	10.0	G
	28	9.7	G
	30	9.0	F
	30	8.8	G
	31	8.8	G
8	1	8.9	G
	1	9.4	F
	2	9.1	G

SZ Cygni

Mo.	Day	Est.	Obs.
8	3	9.5	O
	3	9.3	G
	4	9.6	O
	4	9.8	F
	4	9.4	G
	5	9.5	G
	9	9.6	F
	11	9.6	F
	12	9.4	B
	13	8.9	B
	13	9.3	L
	14	9.0	G
	14	8.8	B
	15	8.8	B
	16	8.9	G
	16	9.5	O
	16	9.3	L
	17	9.4	F
	17	8.8	G
	17	9.2	L
	18	9 0	G
	18	9.2	L
	19	9.3	G
	20	9.0	B
	20	9.6	G
	21	9.8	G
	22	10.0	G
	23	9.6	B
	23	10.0	G
	23	9.6	L
	24	9.7	G
	24	9.6	L
	25	9.3	G
	26	9.6	L
	26	9.3	G
	27	9.4	B
	27	9.2	G
	29	8.6	G
	30	8 5	G
	31	8.5	G
9	1	8.8	G
	3	10.4	F
	3	9.0	G
	4	9.0	B

204405
T Aquarii

Mo.	Day	Est.	Obs.
7	5	8.8	V
	13	9.9	J
	17	9.8	V

205923
R Vulpeculae

Mo.	Day	Est.	Obs.
7	13	9.3	J
	22	9.1	J
	27	9.1	J
8	4	9.2	J
	7	9.4	J
	12	9.3	J
	13	9.3	O
	16	9.5	J
	29	10.3	J

210868
T Cephei

Mo.	Day	Est.	Obs.
7	3	8.2	L
	3	7.9	Hu
	6	8.0	V
	7	8.1	M
	7	8.1	Ba
	8	8.0	G
	9	8.1	M
	13	7.6	Ha
	14	8.2	J
	14	8.0	Ba
	15	8.0	L
	16	7.9	G
	17	8.1	V
	18	8.3	C
	18	7.5	Ha
	19	7.6	Hu
	19	8.2	O
	21	8.2	C
	22	8.1	L
	23	7.5	B
	27	7.9	J
	28	7.4	Ha
	30	8.1	O
	31	8.0	L
8	1	8.1	G
	2	8.2	C
	3	8.1	G
	3	7.7	V
	3	7.2	Ha
	4	7.8	J
	4	8.4	M
	4	8.0	O
	4	8.3	C
	6	8.1	C
	9	7.8	L
	10	8.1	C
	13	7.1	Ha
	13	8.2	M
	13	8.0	C
	13	7.9	O
	16	7.5	M
	16	7.8	L
	16	7.6	J
	17	6.9	Ha
	17	7.8	G
	21	7.2	M
	24	6.7	L
	25	6.7	Ha
	26	7.3	G
	26	6.7	L
	27	6.9	J
	29	6.3	B
	29	7.0	O
	29	6.8	M
	29	6.9	J
	30	6.6	Ha
	31	6.5	Bu
9	2	6.5	M
	4	7.5	Bu
	8	6.4	O
	8	6.6	J

213044
W Cygni

Mo.	Day	Est.	Obs.
7	3	5.5	L
	4	6.0	G
	6	5.5	L
	8	5.4	L
	10	5.5	L
	15	5.5	L
	25	6.1	G
	26	5.7	L
	30	5.8	L
	31	6.2	G
8	4	6.0	L
	5	6.3	G
	8	6.1	L
	17	6.5	G
	18	6.5	L
	23	6.7	L
	25	6.6	G
	31	6.7	G

213678
SC ephei

Mo.	Day	Est.	Obs.
7	1	8.4	Hu
	14	9.7	J
	18	9 2	V
	19	8.8	B
	19	9.0	Hu
	27	10.3	J
	27	8.7	B
8	3	10.0	V
	3	10.5	O
	4	11.0	J
	16	11.0	J
	20	9.4	B
	29	9.6	B
9	9	11.2	O

213754
RU Cygni

Mo.	Day	Est.	Obs.
7	13	8.4	G
	26	8.0	G
8	18	8.8	G
	30	9.1	G

213843
SS Cygni

Mo.	Day	Est.	Obs.
7	1	12.1	Hu
	6	12.1	Hu
	8	11.9	J
	9	11.9	J
	11	11.8	J
	12	12.6	B
	13	11.9	J
	14	11 9	J
	15	12.0	J
	19	12.1	Hu
	20	11.4	J
	21	11.5	J
	22	11.6	J
	25	11.6	J
	26	11.9	J
	27	8.6	G
	27	9.7	J
		9.2	J
	28	8.3	G

VARIABLE STAR OBSERVATIONS July to Sept. 1912.—Con.

SS Cygni				SS Cygni				RV Cygni				V Cassiopeiae				R Cassiopeiae			
Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.
7	28	9.1	J	8	5	10.3	J	8	1	8.0	F	8	12	8.0	J	7	14	8.3	Ba
		8.7	J		6	10.8	J		2	8.1	G		13	8.2	O		15	8.6	B
	29	8.3	J		6	10.7	C		4	7.5	J		14	8.0	F		18	8.8	C
	30	8.4	J		6	11.3	F		4	7.7	F		16	8.5	G		20	8.6	B
	30	8.4	G		7	11.5	J		4	7.6	G		16	7.9	J		24	8.4	B
	30	8.2	C		7	11.0	C		5	7.4	F		17	7 9	F		26	8.6	B
	30	8.3	O		8	12.3	B		5	7.9	G		20	8.1	G		27	8.4	J
	30	8.4	F		8	11.3	L		6	7.6	F		22	7.6	G	8	2	8.9	C
	30	8.3	L			11.7	L		9	7.6	F		24	7.9	J		3	9.0	L
		8.5	L		9	11.7	L		14	8.2	G		24	7.5	G		4	9.1	J
	31	8.4	L		10	11.7	J		16	8.6	J		25	7.8	F		7	9.0	C
	31	8.7	J		10	11.8	L		16	8.2	O		29	7.4	G		10	9.3	C
	31	8.4	C		10	12.0	M		17	8.2	G		29	7.9	J		12	9.3	L
8	1	8.5	G		12	11.9	J		17	7.8	F		31	7.4	G		12	9.2	J
	1	8.5	F		12	12.4	B		18	8.1	G	9	3	8.0	F		13	8.5	B
	1	9.6	M		16	11.9	J		24	8.4	J		3	7.3	G		16	9.3	J
	1	8.4	O		24	11.9	J		25	8.0	G		6	7.5	O		16	9.0	O
	1	8.8	J		29	11.9	J		29	8.0	G		8	7.6	J		20	9.1	G
	1	8.9	L	9	8	11.9	J		31	7.4	G		9	7.6	O		21	9.0	G
	2	8.5	C		213937			9	3	8.1	F		231425				23	9.6	L
	2	9.3	B		RV Cygni				4	7.1	B		W Pegasi				24	8.9	G
	3	8.6	G	7	3	7.4	G		8	8.6	J	8	4	9.1	V		24	9.5	J
	3	9.5	L		8	7.5	G		230110				233335				27	8.6	B
	3	9.0	O		8	8.1	C		R Pegasi				ST Androm.				29	9.0	G
	3	9.0	C		9	8.2	F	9	6	9.6	O	8	3	10.1	O		29	9.5	J
	3	9.4	M		12	7.8	G		9	9.8	O		13	9.9	O	9	1	9.0	G
	3	9.6	J		13	8.0	G		230759				24	10.1	G		8	9.9	O
	4	10.1	V		14	8.1	F		V Cassiopeiae				31	9.2	G		8	9.8	J
	4	10.0	O		14	8.6	J	7	14	10.5	J	9	1	9.1	G				
	4	9.9	J		18	8.1	C		22	9.2	J		6	9.3	O		NOVA GEMIN.		
	4	9.8	G		22	7.9	G		23	9.4	F		8	9.3	O		8	7.3	L
	4	9.7	L		25	7.9	G		27	9.2	J		235350				10	7.2	L
	4	9.0	F		26	8.5	I	8	1	8.2	F		R Cassiopeiae				13	7.3	L
	5	10.9	B		27	8.6	J		4	8.2	O	6	30	8.2	L		18	7.4	L
	5	10.7	G		29	7.8	G		4	8.4	J	7	5	8.5	L		23	8.2	G
	5	10.2	L		30	8.0	F		7	8.3	J		6	8.2	Ba		25	8.3	G
	5	10.8	F		31	7.9	G		11	8.0	F		12	7.9	B				

once reveal the practical nature of the work, and this fact should appeal to many telescopists who are using their glasses to little or no purpose, and lead them to coöperate with us.

Mr. Allan B. Burbeck, of North Abington, Mass., has lately joined the Association. In future reports his observation will be indicated by the abbreviation "Bu".

The splendid set of seventy observations of the variable 123961 S Ursae Majoris, during July, is especially noteworthy. This variable was observed every night in the month save on the 2nd inst., a record that well attests the value of coöperative observing. The rise of a magnitude in the variable 154428 R Cor. Bor. was also closely observed by all our observers.

A maximum of the variable 142539 V Bootis was calculated by Hartwig for July 31. which was not confirmed by our observations, as the variable appears to have been close to the 11th magnitude on that date, which is about its brightness at minimum.

Dr. Gray's contribution of 170 observations calls for special commendation. When a busy physician finds time to use his telescope to such good advantage he sets an example that is worthy of emulation.

Dr. Gray carefully observed the variable 202946 SZ Cygni during the past month with good results. This variable has a range of about two magnitudes in a short period of approximately 15 days.

Mr. Lacchini of Faenza, Italy, also deserves credit for his list of over 100 observations.

The variable 213843 SS Cygni began its characteristic and sudden increase in brilliance July 27. Mr. Jacobs observed a rise of 0.5 of a magnitude on that date, and a gain of 0.3 magnitude the night following. Cloudy weather on these dates interfered with observations of the variable at the critical period by many of our observers.

The feature variable of the August report is unquestionably 194632 χ Cygni, which rose rapidly the third week in the month. Mr. Forsyth telegraphed the fact to Professor E. C. Pickering, Director of the Harvard College Observatory, having observed a rise of three magnitudes between the 17th and 29th of August. A number of our observers observed the sudden waxing of this star with observations well in accord.

In this connection, J. Ellard Gore's note on this star in his volume "The Stellar Heavens" is of interest. "Discovered by Koch in 1686. Max. 4—6.5. Min. 13.5. Mean period 406 days but with some irregularity. A most remarkable and interesting variable. Distinctly visible to the naked eye at a bright maximum. The light variation is enormous, amounting to nearly if not quite 10 magnitudes. This implies that the light at a bright maximum is nearly 10000 times the light at minimum. The star is red and shows a magnificent spectrum of the third type."

For the years 1906-1910 inclusive the estimated maxima as recorded in the Harvard Annals are respectively as follows:—4.3—5.6—4.8—4.2—4.7. At this writing, Sept. 10, the variable is easily visible to the naked eye, about 5th magnitude.

WILLIAM TYLER OLCOTT.
Corresponding Sec'y.

Norwich, Conn., Sept. 10, 1912.

COMMUNICATIONS QUESTIONS AND ANSWERS.

Jupiter and ω Ophiuchi were observed here on the afternoon of the 15th. Clouds intervened however during the occultation. But one measurement could be taken and that only through rifts of cloud. This gave a result of 119°.6 at 3:46 E.S.T. for position. No measure for distance could be taken, but I estimated the star to be roughly at 25″—30″ from the nearer limb of Jupiter, while the position angle was being measured.

A measure on the evening of the 14th yielded the following results:

P.A.	No. of measures	Dist.	No. of measures	Time
101° 47′	4	6′ 17″.5	6	Began 7:15 Ended 7:45 E.S.T.

The instrument used was an eleven-inch equatorial with Repsold micrometer,

A. THOS. G. APPLE.

Lancaster, Pa, Sept. 17, 1912.

Observations of Uranus.—During the months of this last summer I have been observing Uranus with my 2¼″ refractor on almost every clear night. The planet may be easily picked up in the finder, and this year it has been placed in such a position as to be very quickly identified. Uranus has been very close to the double star σ Capricorni and its attendant triumvirate of doubles,—ρ, π and o Capricorni. It has thus been in very interesting company. In my small refractor it appears as a greenish, ill-defined object of about the sixth magnitude, but not at all star-like in appearance. I have also observed Uranus with a 6″ refractor, but not under good seeing conditions. Uranus is easily seen with a small opera glass, but in the dust and haze of the town I have been unable to see the planet with the naked eye. However, while on my vacation, I saw it easily, in the clearer atmosphere of the country, with the naked eye. (Latitude about 45°).

ROBERT H. BOWEN.

Waterville, Maine.

Occultation of Antares.—In spite of the haziness and the clouds on the 26th of June, I got a good view of the occultation of α Scorpii. It disappeared very suddenly at $11^h\ 27^m\ 12^s$ E.T. which is only 2^m different from your prediction.

EVERETT S. KING.

54 Concord Ave., Cambridge, Mass.
July 22, 1912.

A Brilliant Meteor.—Saturday Sept. 7 about 8:45 p.m. I observed a splendid meteor, that passed directly through the zenith, coming from Cygnus and disappearing in the direction of Ursa Major; I counted 7½ sec.; no trail, only 2 or 3 sparks were left behind; size about ½ full moon's diameter; it lit up the country like daylight and where I was the shadow it cast was toward the south, though other buildings which were beyond its path, threw their shadows in the opposite direction. Whether the meteor exploded, fell, or vanished into the universe I cannot say, since the last part of the path was obstructed by dense trees.

H. R. Karstens.

Columbia, S. C., Sept. 10, 1912.

The Society for Practical Astronomy: An Appeal to Amateur Astronomers.—I take pleasure in announcing to the readers of POPULAR ASTRONOMY that the ninth Observing Section of the Society for Practical Astronomy has recently been established. This latest one is The Section for the Study of the Auroræ, the Zodiacal Light and the Gegenschein, the Director of which is Mr. Alan P. C. Craig, Star Rural Delivery, Corona, Cal. The Section has been formed in response to my letter in the April, 1912, number of P. A., ("Communications," p. 253), and practically completes the long list of Observing Sections which we proposed to establish in the S.P.A. for the benefit of its members, and which were necessary to comprehensively cover every branch or line of observation pursued by amateur astronomers and practical astronomers in general. Now that we can safely say that our purpose is at least in a fair way accomplished, it would seem as though the suggestion made by Editor

H. C. Wilson in the August and September, 1911, issue of this journal, (Vol. XIX., pp. 456-457, "Notes for Observers"), in regard to our having here in America an association of observers with an Observing Section for each branch of study, has at last been perfectly realized in this organization, The Society for Practical Astronomy. This Society, which, as many of my readers doubtless already know, is an international one, offers work for the amateur astronomer in practically every possible kind of observation in which he can profitably be interested, through the media of its "Observing sections," as one can see by an inspection of the following list of its separate Sections, together with which is also given the name and address of the Director of each:

Section.	Director.	Address.
Variable Star,	William Tyler Olcott,	62 Church St., Norwich, Ct.
Planetary and Lunar,	Latimer J. Wilson,	1405 Gartland Ave., Nashville, Tenn.
Solar,	Richard H. Swift,	4839 St. Lawrence Ave., Chicago, Ill.
Photographic,	Horace C. Levinson,	4049 Lake Ave., Chicago, Ill.
Meteor,	Prof. Charles P. Olivier,	Agnes Scott College, Decatur, Ga.
Comet,	Weston Wetherbee,	5 Ingersoll St., Albion, N. Y.
Double Star,	Hibbert Perceval Newton,	Irvine's Landing, B. C., Canada.
Nebula and Star Cluster,	R. L. Doherty,	Palmyra, Mo.
Auroræ, Zodiacal Light and Gegenschein,	Alan P. C. Craig,	Star Rural Delivery, Corona, Cal.

An invitation is extended to each member of the S. P. A. to join whatever one or two Observing Sections comprise the field or fields of observation in which he is engaged or which interest him most. Once enrolled in a Section, a member is in a position to coöperate with the other members of the same Section, and, under the direction of the Director, to make his work count for something and even for some scientific value. The Director of each Section endeavors to be of all the service he can to the members of his Section, and they are given the advantage of correspondence with him, exchange of notes with one another, etc. The reports of the work of the entire Sections are prepared by the Directors, (as frequently as it is advisable), and these are published in "The Monthly Register of the S. P. A." Hence, every member belonging to an Observing Section has the opportunity of making just as much of his observations as he personally desires to, and to contribute to the output of his Section and its usefulness to the Society and ultimately to astronomy. I could continue to write of the virtues of the Observing Sections, and occupy many pages in an exhaustive account of them, but so much at present on the subject will have to suffice. What I would like to do, however, is to impress upon and show all amateurs who are not familiar with them, their value, which can only fairly be appreciated when one pauses to consider how much good a united body of observers who are all coöperating can do, working with a common purpose in view and striving to the same ends. Good examples of the results attained by such coöperative observing are to be found in the reports of the several Sections which appear in almost every issue of our "Monthly Register."

At present a movement is in progress in our Society for the publication of "Circulars" which shall contain the news of all important and interesting astronomical discoveries, cometary ephemerides, and other information useful to amateurs. These will be furnished to members at a small additional cost, (about fifty cents), to the regular annual subscription. In the opinion of the management of the Society, these circulars should prove to be invaluable to all members who are not otherwise in a position to receive conveniently or without

considerable expense, the sort of news which they are intended to convey, and everyone who has yet expressed an idea on the plan apparently seems to share our views. These circulars should be another very useful feature of this Society to amateurs.

The membership of the S.P.A. consists now of about seventy persons. As has been said, the Society is an international organization, and is intended for both professional and amateur astronomers, although it at all times endeavors to encourage and promote the work of the latter class, and welcomes all amateur observers for members. It has members living all over the United States, and in Canada, England, Italy, Roumania, Cape of Good Hope, (South Africa), Australia and the Philippine Islands, while "The Monthly Register" is read in almost all parts of the Globe. Nevertheless, by far the largest percentage of its membership is to be found in the United States, (which fact is quite a natural one), and in this country must its greatest growth in the future be expected, although our foreign colleagues are of course at all times equally welcome. I think I am safe in saying that there is really no *amateur* astronomical organization in this country, excepting the S.P.A., which is not more or less restricted to a certain town or locality, and that there is none, (again excepting the S.P.A.), that would correspond to the United States in a similar way to that in which the British Astronomical Association, for example, corresponds to the British Isles. Now I do not mean to aver by the preceding statement that there are no amateur astronomical societies in this country other than this one, nor anything but that they are all right in their place and are admirably filling their purpose, but, as a rule, they are confined to certain geographical districts or places, while the S.P.A., on the contrary, as far as my knowledge extends, is the only one that is not thus restricted. We should like to make this Society to the amateurs in America, (particularly the U. S.), what the B.A.A., for instance, is to amateurs in Great Britain, and we want their support in accomplishing this. The prime purpose of this article, therefore, is to earnestly petition that support. Why shouldn't we, here in America, have an organization for amateurs similar to that of the B. A. A. in its country? All of my readers, I am positive, will agree with me that we should. That being the case, then let us make the S.P.A. just such an organization! This is my appeal to amateur astronomers; I would ask them to realize the possible value of this Society to them and to American amateur astronomy. This association being the least restricted of all kindred organizations, it is no more than right that it should receive the support of the amateurs of America generally, and become the one big American society of astronomical observers.

The membership of the S.P.A. is steadily advancing, but it is our motive to increase that membership many-fold in the near future. We would have it understood, however, that we do not wish to acquire a large membership merely for the purposes of increasing the *size* of our organization, but what we do wish to do is to increase the number of united amateur *workers* and see whether we can be of service to them and finally to astronomy in getting them to work and to observe systematically. And this Society should be the expression of such a unison. We would rather have a small membership and an active one than a large and inactive one, but what we are seeking is *both* a large *and* an active one, and our purpose in attempting to bind together the amateurs in this country, (and if possible those all over the World), is to advance amateur astronomy and to establish one large astronomical organization which will at all times mainly consist of and welcome the amateur.

In conclusion, I extend a hearty invitation to all amateurs who are not members of the S.P.A. and who feel at all inclined toward uniting with us to become members of our Society. No great demands will be made or expected of anyone except that he be an observer of the heavens and will try to do what he can in the Society in the way of contributing to the work of the organization, and, if it so pleases him, of joining an Observing Section or so and coöperating with the other members therein,—but this last remark is simply a suggestion on our part for the good of the member concerned and is left entirely to his discretion and decision. We will faithfully promise to do all we can to encourage and advance the work of every member of the Society; consequently, with the aid of its Observing Sections, the S.P.A. should be of utmost utility to every member thereof. The annual membership subscription, (there being no entrance fee), is but one dollar, including that to our official organ, "The Monthly Register." This amount may be sent in to the writer, together with a request that he enroll the name of the sender as that of a member of the S.P.A., by all amateurs who, (being observers), are desirous of joining the Society. No preliminary communications are necessary, as sufficient particulars are given in this article. I shall be pleased to hear from anyone who wishes to join our Society, and sincerely trust that a response to this appeal will be received from all concerned who feel in the least interested in joining hands with us. In final conclusion, permit me to say that I hope that our aim to make the Society for Practical Astronomy the great amateur astronomical organization of America can speedily be realized and carried into effect with the support of all American amateur observers and friends interested in the welfare and promotion of amateur astronomy in general. Allow me to thank the Editor of POPULAR ASTRONOMY for his kindness in publishing this entreaty, thus giving it adequate circulation.

FREDERICK C. LEONARD,
President of the S. P. A.

1338 Madison Park, Chicago, Ill.,
1912, August 16.

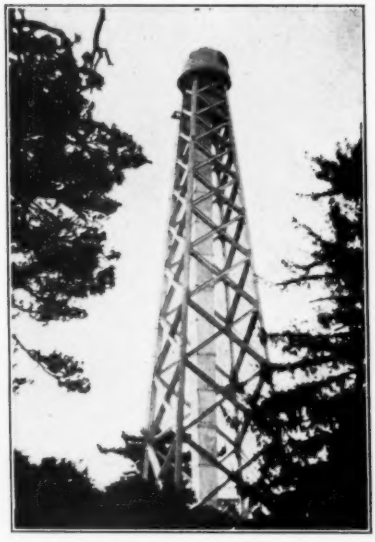
A Visit to the Mount Wilson Solar Observatory.—During one beautiful California day last April, I desired to see the 100-inch glass disk which, at the time, was being polished in the solar observatory machine and instrument shops at Pasadena, Cal., and which will be, if completed, part of the great reflecting telescope to be mounted on the summit of Mount Wilson Arriving at the shops, I was shown about by one of the office assistants who afterward introduced me to a prominent astronomer belonging to the observatory staff who, in turn, gave to me a card of introduction which, on August 1, caused a long and pleasant tramp to the top of Mt. Wilson.

Soon after arriving there and making use of the card, I was shown through one building after another by one of the assistants there,—commencing at the power house and ending with the museum of the observatory. This article would be much too long for its purpose if a detailed description of the buildings and instruments were given. A few facts however may be interesting.

The 150-foot tower telescope was very interesting throughout, and the small 60-foot tower telescope—the spectroheliograph of which is dismantled—like the large one, showed the skill necessary for designing and constructing it even though its purpose was first experimental. The Snow horizontal telescope and accessories occupied part of the time between 3 p.m. and 5 p. m. of

that day. Next was the famous 60-inch reflecting telescope. As usual, it is in constant use during darkness when conditions permit; however, it could not be seen on account of a heavy room-like covering that aids in minimizing thermal changes which would otherwise impair the excellence of its work. The building and dome, sheltering the telescope, are equipped with an excellent electric motor and control system for moving the instrument, heavy dome and other movable parts. The observatory museum, which is open to the public, contains many interesting and remarkable photographs nearly all of which were made with the instruments here. Perhaps the photographs attracting special attention are two of the 100-inch telescope model which was designed and constructed in the observatory shops and sent to Washington, D. C.

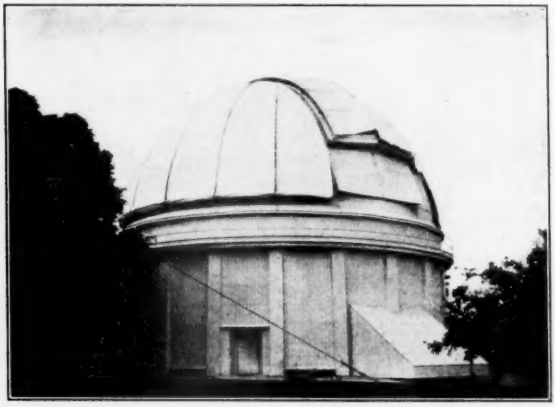
THE 60-FOOT TOWER TELESCOPE



THE 150-FOOT TOWER TELESCOPE

Some noticeable features may be of interest, although one must bear in mind that the model—the photograph of which I saw—is subject to alterations or improvements. As illustrated, a change in the mode of mounting is conspicuous. The great size of the tube for the 100-inch mirror has perhaps made the change necessary, but the mounting is less convenient in photographing the region of the sky close by the north celestial pole—for that region cannot be "reached" on account of the mounting. It will be seen that the 60-inch telescope, as illustrated in P. A. Vol. XVIII, Plate III, has a huge fork bolted rigidly to the upper end of the polar axis to carry the skeleton tube; but the 100-inch mirror in its tube may be really carried by a double fork having its tine united in two places in which the bearings for the declination axis will rest. In other words, the frame for carrying the tube resembles a turn-buckle in shape, having the polar axis in two sections that correspond in position to

swivel and screw thread of the latter. The mounting is simiiar in principle to that of the photographic telescope of the Paris observatory as illustrated in Young's "Elements of Astronomy" facing page 309 and in his "General Astronomy" facing page 491. A large cylindrical foundation of concrete, perhaps having a diameter of about 95 ft. and thickness of 35 ft., with concentric steps leading down from near the edge into a depression about 10 feet deep about the center serves as a base. Near the circumference of the foundation (the top of which may serve as a floor), at the north and south points, rise two huge piers of different heights to hold the bearings of the polar axis and bear the great weight of the moving parts. Two large metal floats of equal size, floating in mercury tanks—one float being fastened to the upper end of one section of the polar axis while the other float is attached to the lower end of the other section—may be an indispensible part of the mounting in that they will take off a great part of the enormous weight of the moving parts that would otherwise be a burden on the polar-axis bearings. A great dome to be about 90ft. in diameter will shelter the telescope from the weather.



THE DOME FOR THE 60-INCH REFLECTOR.

Concerning one optical part, there has been much doubt in the past whether the 100-inch glass disk could be used. Not so very long ago it was abandoned for a time, but taken up again with much hope that it will suffice; if not, a new disk may be had. At present, Aug. 3, the spherical surface is approaching to some degree the theoretical surface, the focus being off by less than one inch. Completion will require some time to come. When the spherical surface is finished and tested, then it will be transformed into a paraboloidal surface before it can be used successfully for celestial photography.

GILBERT LANHAM.

Hollywood (Los Angeles), California.

Question.—Where can I find instructions how to set the small plane mirror or prism in a Newtonian telescope?

ANSWER.—The John A. Brashear Co., Ltd., kindly allow us to print the following instructions, and suggestions, which will no doubt be of value to many others besides the writer of the question:

How to Adjust a Newtonian Reflecting Telescope.

First Adjustment of the Diagonal Mirror. Take out the lenses of a medium power eyepiece, and then replace the cap, slip this in the eye tube, and the opening formed by the cap and diaphram of the eyepiece will answer nicely for adjusting. The flat can be made approximately correct, either with the cover on the speculum or the speculum out of the tube altogether. Presuming the cover is on the speculum, it is only necessary to bring the reflected image of the cover into the center of the flat, or as generally known, the diagonal mirror This can easily be done while looking through the opening in the eyepiece, by the aid of the three milled head screws in the mounting of the flat. The center screw, called the clamping screw, should be slightly loosened before moving the others, and when the adjustment is correct, pretty tightly clamped. The central screw need not be loosened for slight adjustments as it has a yielding spring washer under the collar. This adjustment can be made in a few moments by any one.

Adjustment of the Large Mirror. Having uncovered the large mirror, look into the eyepiece again, and if the large mirror is perfectly adjusted, not only will the reflection of the diagonal mirror be seen central, but the three springs which hold the diagonal mirror will be seen of equal length, and the image of the large speculum will be concentric with the end of the tube opposite it. The adjustments of the speculum are made by the screws at the back of the cell. The iron clamping screws should always be slightly loosened first, then the brass adjusting screws can be moved with ease. It will not take an observer five minutes to find out how to move the screws, especially if he has some one to move them for him while he looks into the eyepiece, as he will know at once whether the reflections are moving in the right or wrong direction; and the fact is, a few moments of practical work in this line is worth a great amount of book knowledge. Some workers with the reflector take off a small spot of silver on the center of the speculum, about one quarter of an inch in diameter, to aid in making a perfect adjustment of the flat, a disc of white paper is now used instead of this, to facilitate adjustment (it is only necessary for a novice,) but I have never found this necessary as the concentricity of all the reflections is what is required, and, in the hands of ordinary persons, is quite an easy and pleasant task after a few nights practice. The adjustments can all be made in the daytime. For the final adjustments it is best to use an artificial star, in the day time, or preferably a real star at night. Care, however, should be taken to get the speculum correct in the daytime, leaving the final adjustments of the flat for the night.

Final Adjustment of the Flat. Turn the telescope on a second magnitude star, put in a medium or high power eyepiece, with the lenses in their proper place. Now, having focused the star, move the eyepiece outward so as to expand the star disc. If the expanded disc is equally alike in brightness and the diffraction rings are concentric, and of equal brightness all around, the adjustments are perfect. If there is a flare on one side, that part of the flat mirror toward which the flare appears to extend should be moved away from the eye, or the opposite side toward the eye. The star disk should be kept central in the field of the eyepiece, or the edges of the lenses of the eyepiece may lead to errors.

A few nights practice will bring all right, and the adjustments once correct will remain so with ordinary care. We always send out the telescopes we make in good adjustment, yet they should be examined, as they might be altered by a jar in shipment.

REMARKS TO THOSE WHO MOUNT THEIR OWN TELESCOPES. 1st. The eyetube should be as nearly as possible at a right angle to a line drawn through the center of the telescope tube. This need not be rigorously so, but it is the best position.

2nd. The diagonal mirror should be in the center of the diameter of the large tube. It can be readily placed there by adjusting the three screws that extend outside the tube by which it is held. It should always be central with the eyetube; and to secure this, the three holes, through which the three screws just referred to pass, should be made oblong in the direction of the length of the tube. Its centrality or error can readily be seen when looking through the eyepiece with the lenses removed. When central a dark ring, which is the tube back of it, is seen of equal width all around.

3rd. It is always best to make the adjustments with the telescope at an angle of about 45 degrees, and when making the final adjustments a star at this angle, or higher, should be chosen, to avoid as much as possible the atmospheric disturbance near the horizon. If the expanded star discs are "crawling," as some call it, real good adjustments cannot be made, and it is better to wait until the air is steady to finish the adjusting. A good night is as necessary as a good telescope, and the steadiness of a star disc is evidence that the night is good. When the reverse is the case, good definition is impossible. An expanded star disc is a very excellent guide; for if it is steady, good work should be done, if it is much disturbed the atmospheric conditions are not good. It may be however, that the tube has not come to an equilibrium with the surrounding air, in which case a little time is all that is needed, unless the temperature is changing rapidly.

HOW TO TAKE CARE OF A REFLECTING TELESCOPE. 1st. Never take it from a cold to a warm place without first covering the silver surfaces.

2nd. If the silver surface should become damped, dry it thoroughly some distance from the fire, and then it will polish nicely; but do not attempt to repolish when damp. I have had silver surfaces come out all right after it had rained on them, when they were thoroughly dried before repolishing.

In my early work with the telescope the lower end of the tube was left open, and I have been frequently caught in a shower of rain before I could take my telescope indoors, but I always saved the reflecting surfaces, if I cared to save them.

3rd. Always keep the flat and speculum covered when not in use.

4th. The silver surfaces may be repolished by following the method given in the silvering process, except that only the roughed pad need be used, after the surfaces are well dusted off with a piece of clean cotton.

5th. If using the telescope in an observatory, never have many observers in at a time, as the heat from the bodies passing out the slit in the dome causes bad definition. Never discard a hazy night, if it is clear enough for work, as hazy nights are very frequently the best for double star work.

A good teleseope is well worth the best of care, as it is always a source of genuine pleasure and profit.

GENERAL NOTES.

Dr. Karl Schwarzschild, director of the astrophysical observatory near Potsdam, has been elected a member of the Berlin Academy of Sciences. (*Science*, Aug. 23, 1912).

Dr. Jean Mascart, of the Paris Observatory, has been appointed director of the Lyons Observatory in succession to M. André (*Science*, Sept. 13, 1912).

Dr. Ernest Emil Hugo Becker, director of the Observatory of the Imperial University of Strasburg, died Aug. 5, 1912.

Dr. E. A. Fath, who has been connected with the Mount Wilson Solar Observatory for the past three years, has been appointed director of the Smith Observatory of Beloit College, Beloit, Wisconsin. While at Mt. Wilson Dr. Fath's work consisted in observations with the 60-inch reflector, primarily on spectra of spiral nebulæ and globular star clusters.

New Observatory of "Montserrat" at Cienfuegos, Cuba.—The first number of the Annals of this observatory, inaugurated in 1910, have just come to hand. The principal work of the observatory is meteorological, especially the study of the hurricanes which frequently cross the Gulf of Mexico. The equipment includes a few small astronomical instruments in addition to the usual meteorological apparatus. The director of the observatory is Simón Sarasola, S. J.

A Literary Supplement to the *Astronomische Nachrichten* is a new feature of that magazine which is apparently to appear monthly, containing brief reviews of important articles which have appeared in other publications. Nos. 1 and 2, for July and August 1912 have come to hand.

Dedication of the New Allegheny Observatory.—The new Allegheny Observatory, situated in Riverview Park, Pittsburgh, was dedicated on the afternoon of Wednesday, August 28, in the presence of the members of the Astronomical and Astrophysical Society of America and of many of the Pittsburgh friends of the institution. The principal instruments of the new observatory are a 13-inch visual refractor, a 30-inch reflector (a memorial to James Edward Keeler, and a 30-inch photographic refractor (a memorial to William Thaw and his son, William Thaw, Junior). The last of these telescopes is not quite completed, as the objective remains to be supplied.

Addresses were made by Dr. John A. Brashear, Chairman of the Observatory Committee; by Dr. Samuel Black McCormick, Chancellor of the University of Pittsburgh, of which the Observatory forms the astronomical department; by Dr. Frank Schlesinger, Director of the Allegheny Observatory; and by Professor E. C. Pickering, Director of the Harvard College Observatory, Mrs. William Reed Thompson, the daughter of William Thaw and the sister of William Thaw, Junior, closed the exercises with the unveiling of the memorial tablet on the Thaw Telescope.

New Observatory Planned.—Mr. T. S. H. Shearman, Government Astronomer and Director of the Vancouver Meteorological Station, is attempting to enlist interest in the establishment of an observatory on Grouse Mountain. Grouse Mountain is situated near the city of Vancouver, B. C. At present there is a project on foot to build a railway to the top of the mountain. This enterprise and the construction of an observatory on the summit would be mutually helpful. An observatory on this mountain would be at about the same altitude as the Lick Observatory and the atmospheric conditions are said to be much the same at the two places. The observatory may be built as a private enterprise by citizens of Vancouver, or it may become a part of the large provincial University which is being started. A tentative plan of building has been adopted. Mr. Shearman is planning to construct a reflector with an aperture of ten feet as the principal instrument of the observatory. Such an instrument if successfully constructed and mounted would attract the attention of the astronomers everywhere.

Conjunction of Lutetia (21) with Jupiter.—I have noted that you make mention in POPULAR ASTRONOMY of the possible conjunction of Lutetia (21) with Jupiter on June 7.61 G.M.T. As I have a position of Lutetia at about that date I am sending it herewith, hoping that it will be of use to some one. It may be noted also that I have an image of the asteroid on a plate taken June 12, but as there are no catalogue stars on the plate its position has not been reduced. A position could be obtained however, if it should prove to be of sufficient importance.

LUTETIA (21).

1912	P.S.T.	α 1912.0	δ 1912.0
June 15	$10^h\ 3^m\ 0^s.0$	$16^h\ 24^m\ 7^s.31$	$-21°\ 5'\ 59''.9$

D. W. MOREHOUSE.

Lick Observatory University of California,
Mount Hamilton, Aug. 6, '12.

The Southern Milky Way.—In the Annals of Harvard College Observatory, Vol. 72, No. 3, Professor Solon I. Bailey gives an account of a series of long exposure photographs of the southern Milky Way, illustrated by nine plates which together cover the southern 180° of the Galaxy. The instrument employed was a Cooke lens, about one and a half inches in diameter, mounted equatorially and driven by electric impulses furnished every second. The focal length was about thirteen inches and the field covered upon an 8x10 plate was about 30° by 40°, or one fortieth of the whole sky. The definition is good over the greater part of each plate, the images being seriously distorted only by the effect of differential refraction over so large a field during a long exposure. The durations of the exposures range from $10^h\ 43^m$ to $21^h\ 0^m$, each requiring from two to five nights. A great wealth of detail in the structure of the Milky Way is shown upon these plates. The background over much of the area is apparently nebulous, overlaid or broken up by a great variety of dark holes and lanes.

All the photographs were taken at Hanover, Cape Colony, by Mr. L. G Shultz and Professor Bailey. Hanover is situated on the vast plateau of South Africa, in the Great Karroo, at an elevation of 4,500 feet.

Dayton Astronomical Society.—The Dayton, Ohio, daily papers of Aug. 9, 1912, published architect's drawings of the proposed memorial building to the Wright Brothers, of aviation fame. The plans are yet purely tentative, but their publication evidences a purpose on the part of the citizens of Dayton to go ahead with the proposal. The suggested cost of the memorial is from $250,000 to $500,000 and the plans call for a great building containing a museum of aviation, geography, electricity, mechanics, etc., a scientific library, an aviation laboratory, a large auditorium and an astronomical observatory.

Mr. R. E. Fosdick, director of the observatory of the Dayton Astronomical Society, asks for suggestions from the scientific world in all branches, and would be glad to receive from any of the observatories plans and cuts of their buildings and apparatus, which might be of use in preparing plans for the new observatory. His address is Dayton, Ohio, P.O. Box 453.

Professor Langley.—Dr. Pickering, in his address at the dedication of the Allegheny Observatory, gave some interesting and delightful reminiscences of its former directors. The first director held the peculiar theory that the telescope was to be kept but not used, and he defended this theory with a shotgun. At last he went crazy and wrote a poem, though Dr. Pickering said he would not allege any connection between the two events. In this poem he predicted that the object glass of the telescope would be stolen, and, singularly enough, this prediction came true, although it was proved that the author of the prediction had no complicity with its fulfilment. Professor Langley told Dr. Pickering of the long negotiations carried on with the thief for the return of the glass, which was held for a ransom. Dr. Langley and the trustees of the observatory resolutely refused to give any ransom, for then every large object glass in the country would have been at the mercy of thieves. At length Professor Langley and the thief met by arrangement in the woods and held a consultation which ended by the thief saying to Professor Langley, "You and I are gentlemen and we must trust each other." The glass was returned without any money being given. Dr. Pickering paid a high tribute to Professor Langley, whom he knew intimately and often walked with. Langley was then deeply interested in mechanical flight, and when they would see a hawk or large bird in the air he would stop and, looking at it long and intently, would say, "Some day we shall do that." It was his invention of a mechanical flyer, driven by steam, which almost succeeded, that opened the way for the aeroplane, of which he was the real father. It is always true in every forward step of civilization that other men labor and we enter into their labors. (*The Presbyterian Banner.* Sept. 5, 1912.)

An Instance of Scientific Accuracy.—If Pittsburgh does not know what a distinguished scientist it has in its Observatory it should have heard Dr. Edward Pickering tell his audience of the work and wonderful achievements of its Director, Frank Schlesinger. He has become a great expert and authority on stellar parallaxes and spectroscopic binaries and his work is quoted all over the world. He has attained astonishing accuracy in determining the distances of stars by photographic processes. The measuring of the parallax of the nearest star, or angle subtended by the diameter of the earth's orbit at the distance of the star, is the same as measuring the height of a man at a distance of two hundred miles; yet Professor Schlesinger has determined this

to within one inch. The North Pole wanders around within a circle or fence only seventy feet in diameter, and the position of the Pole has been determined within two or three feet. These are instances of the marvelous accuracy attained by modern instruments and methods in measuring astronomical distances, and some of the best work in this line is now being done right here in smoky Pittsburgh. And it might be said that it has been discovered that the smoke of this city in some ways adds to the efficiency of the telescope by cutting off the disturbance of the sun's heat. In a conversation with Dr. Pickering we asked him if the 30-inch telescope in the Allegheny Observatory is one of the greatest telescopes in the world. "It will be," he answered, "with Professor Schlesinger behind it." And so the greatest star is at the little end of the telescope, and it is the man behind the telescope, as it is the man behind the gun and the tool, the pen and the sermon, that does the work. (*The Presbyterian Banner*, Sept. 5, 1912.)

A Comet that Discovered a Man.—Director Schlesinger in giving an account of the work that is being done at the Allegheny Observatory said that astronomers do not aim at making startling discoveries, but rather at carrying on the daily routine of observation and working at old problems. There might well be written over the door of an observatory, he said, the legend; "Abandon hope of making discoveries, all ye who enter here." He illustrated the point by saying that sometimes a discovery made the man rather than the man made the discovery, and told of the case of an obscure astronomer down in Nashville who discovered a comet. This drew attention to the astronomer, who was then called to the Lick Observatory, where he made no more discoveries, but is doing patient, faithful and fruitful routine work. "So in this case," said Mr. Schlesinger, "the comet may be said to have discovered the man, rather than the man the comet." It is often so in life. It is not the men who are seeking to do sensational things and attract attention to themselves who are doing the most useful work, but they who patiently pursue the path of daily duty and let come what will. They may not discover a comet, but some comet may discover them, or at least their service will not be forgotten and their true reward is sure. (*The Presbyterian Banner*, Sept. 5, 1912.)

The reference is doubtless to Professor E. E. Barnard, who, however, made his greatest discovery, that of the fifth satellite of Jupiter, while at the Lick Observatory. He is now an astronomer at the Yerkes Observatory and doing most valuable work with the great 40-inch telescope, as well as with the Bruce telescope. Ed.

Observing the Flash Spectrum during a Partial Eclipse.—At the meeting of the Royal Astronomical Society on June 14, 1912, Professor A. Fowler spoke of some interesting observations which he made of the chromospheric bright lines in the spectrum at the cusps of the partially eclipsed sun on April 17 last, and called attention of observers to the possibility of doing much important work upon the study of these lines during partial eclipses and the partial phase of total and annular eclipses. He said:

"It will facilitate explanation to suppose, what is approximately true, that there are three strata of luminous vapours surrounding the photosphere: (1) the flash-stratum, or reversing layer, about 1″ in depth; (2) an intermediate stratum, 3″ or 4″ in depth, in which enhanced metallic lines are prominent; (3) a

stratum about 10″ in depth, in which lines of hydrogen and helium occur. At ordinary times, with such instruments as I employ, only the lines of hydrogen and helium can be observed. If one attempts to place the slit on the lower strata the bright lines are obliterated by the photospheric light which enters the slit in consequence of "boiling" at the limb. During partial eclipse, however, these lower strata may be observed to greater advantage than at ordinary times, because their projections beyond the cusps are greater than their vertical depths as soon as the angle at the cusp has become less than 90°. This occurs when the magnitude of the eclipse is about 0.3, and no advantage is gained up to this stage. The spectrum of the intermediate stratum began to be recognisable 35 minutes before mid-eclipse, when the magnitude was about 0.55; that is, enhanced lines of iron and other metals were seen in addition to the lines of hydrogen and helium. From this time there was a gradual increase in the number of bright lines, exactly as in passing through metallic prominences of increasing activity. Fifteen minutes before mid-eclipse, when the magnitude was about 0.8, the flash stratum was considered to be fully revealed. The bright lines were so numerous that it was impossible to record all of them, and the difficulty was increased by the darkness of the sky-spectrum by which the identifications had to be made. Having no photographic installation for solar work, one felt very helpless when confronted with such a spectrum, but with the assistance of Mr. Storey, of Edinburgh, who was present at the time, about 70 lines between *b* and D were identified. Many of these were familiar to me from their occurrence in metallic prominences, and the remainder were reversals of well-marked Fraunhofer lines. The flash-spectrum remained visible for about 30 minutes. Afterwards the lines rapidly diminished in number until 35 minutes from mid-eclipse, after which no advantage was gained. From comparisons with results obtained during total eclipses, it would appear that the bright lines were observed when the strata producing them projected not less than 3″ or 4″ beyond the cusp. Observations were thus effectively made closer to the cusp than to the limb in ordinary observations. Darkened sky doubtless assisted to some extent, but the possibility of observing so close to the cusp was probably due chiefly to the reduced effect of boiling at that point as compared with that at the limb. Near mid-eclipse, a careful search was made for the green corona line, but without success.

"The general impression left by the observations is that large partial eclipses, and the partial phases of annular and total eclipses, might be utilized for spectroscopic observations to a much greater extent than has hitherto been thought possible. It has generally been supposed that effective work on the flash-spectrum was restricted to about 2 seconds at the beginning and 2 seconds at the end of totality, but my observations show that even in a partial eclipse of magnitude 0.9, valuable work might be done during 30 minutes. In a total eclipse the time would be extended to nearly 50 minutes. An additional 40 minutes would be available for investigating the high-level lines of the intermediate stratum. Long exposures with very powerful spectrographs might therefore be given, and there seems to be no reason why we should not get the bright-line spectra on the scale of Rowland's map. Interesting investigations relating to the wave-lengths of the lines in different solar latitudes might then be undertaken. The observations thus suggest a further field of work for eclipse observers, and I quite expect that on my next expedition the most important results will be those obtained during the partial phases."

On the Real Motions of One Hundred Stars of Large Proper Motion whose Radial Velocities have been determined.—In the *Lick Observatory Bulletin*, No. 214, Professor H. C. Wilson presents the results of the computations of the apices of motion and absolute velocities in space of one hundred stars whose annual proper motions exceed 0″.4, and whose radial velocities have been measured. The list includes nearly all such stars, excepting those which are spectroscopic binaries whose orbits are not yet well determined. For fifty of these stars fairly good measures of parallax were found. In order to include the other fifty the computations were carried through with three assumed values of the parallax for each star, generally $\pi = 0''.05$, 0″.10 and 0″.20.

Charts of the apices and the range through which they pass under the *assumed* values of the parallax show clearly a tendency to arrange themselves along the Milky Way, in contradistinction to the stars themselves, which seem to shun this region. There is a manifest crowding of the apices in the region having its center at about $\alpha = 90°$, $\delta = +30°$, showing a tendency on the part of this particular list of stars to move within 30° of a common direction, toward a point near the conjunction of the constellations Auriga, Gemini and Taurus. There are less marked indications of a clustering of the apices in the opposite part of the sky, around the point $\alpha = 270°$, $\delta = -30°$; and again in the region about $\alpha = 110°$, $\delta = -40°$; but they are much fewer and more widely scattered in these regions.

The average velocity of 46 stars, for which the parallax has been measured comes out 55 kilometers, the different spectral classes exhibiting a decided variation, as shown in the following table:

Class	No. of Stars	Average Parallax	Average Velocity
A	6	0″.17	25.2kilometers
F	15	0 .10	45.7
G	15	0 .16	72.3
K	10	0 .18	60.5
	46	0 .145	54.9

There are a few "runaway" stars for which no probable adjustment of the parallax will bring the velocity below 100 kilometers per second. The two swiftest moving stars are probably Groombridge 1830, with a velocity of about 285 kilometers, and Cordoba Zones 5^h243, with a speed of about 260 kilometers per second.

About a dozen stars of this list are possibly members of the Taurus stream, although widely scattered over the sky, and five possibly belong to the swift moving stream, discovered by Mr. Benjamin Boss, with its apex at about $\alpha = 110°$, $\delta = +8°$, and velocity 79 kilometers.

Astronomical and Astrophysical Society of America.—The fourteenth meeting of this society was held at the Allegheny Observatory and the Schenley Hotel, Pittsburgh, from Tuesday to Friday, August 27-31, 1912. We are indebted to Professor Philip Fox, the newly elected secretary of the society, for the data from which the following report is made up. Sessions were held at the Observatory on Tuesday and Wednesday, the afternoon of Wednesday being occupied by the exercises of dedication of the new observatory. The account of the dedication and the inspection of the

observatory are given elsewhere in this journal. During the inspection many took the opportunity to visit the crypt under the Keeler Memorial Telescope to pay their respects to the memory of James Edward Keeler and Mrs. John A. Brashear, whose ashes repose there under this beautiful inscription.

"We have loved the stars too fondly to be fearful of the night."

On Thursday and Friday the sessions were held at the Schenley Hotel. An excursion to the Homestead Steel Plant of the Carnegie Steel Company and a visit to the Carnegie Institute added much to the pleasure of the meeting.

The following members were in attendance: A. G. T. Apple, R. H. Baker, L. A Bauer, B. Boss, J. A. Brashear, Miss Annie J. Cannon, G. C. Comstock, Z. Daniel, A. E. Douglass, W. S. Eichelberger, Philip Fox, Edgar Frisby, Miss Caroline E. Furness, Wm. Gaertner, Miss A. M. Harwood, F. C. Jordan, T. A. Lawes, F. B. Littell, R. J. McDiarmid, J. B. McDowell, D. B. Marsh, O. L. Petitdidier, E. C. Pickering, J. S. Plaskett, A. W. Quimby, H. Raymond, E. D. Roe, Jr., H. B. Rumrill, F. Schlesinger, W. L. Scaife, H. Shapley, A. N. Skinner, F. Slocum, Elliott Smith, C. E. St. John, Delisle Stewart, R. M. Stewart, Miss Helen M. Swartz, S. D. Thaw, Miss Stella May Udick, C. E. VanOrstrand, Miss S. F. Whiting.

Visiting astronomers: Louise S. Smith, A. VanMaanen.

The following new members were elected;

Miss Stella May Udick, Allegheny Observatory.
Messrs. Harry Raymond, 3 Elborn Place, Albany, N. Y.
James Hartness, Springfield, Vt.
Arthur Newton, U. S. Naval Observatory.
Henry G. Gale, University of Chicago.
David Rines, U. S. Naval Observatory.
E. S. Haynes, University of Missouri.
William Lucian Scaife, Pittsburgh, Pa.
James B. McDowell, Pittsburgh, Pa.

The constitution of the Society was amended so that Article II on membership now reads:

1. Those persons whose names were signed on or before September 15, 1899, to the annexed statement of desire to form such an association shall constitute the charter members of this Society. The charter members, together with such other persons as may be elected by the Council hereinafter provided shall constitute the members of this Society.

2. Upon nomination by not less than five members, the Council may elect to honorary membership one astronomer of distinction at each annual meeting. American astronomers shall not be eligible to honorary membership. Honorary members shall be exempt from assessments, and shall be entitled to all the privileges of the Society.

3. Any person who has rendered conspicuous service to Astronomy otherwise than through scientific contributions may be elected by the council to be a patron of the Society.

4. The Council shall prepare and publish in the form of by-laws uniform rules for the election of members, honorary members, and patrons.

In accordance with Section 2 of the amended Art. II, nominations for honorary membership were received. Sir David Gill was unanimously elected the first Honorary Member of the Society.

The Council voted to hold no meeting in the summer of 1913, because of the probable absence of a number of the members in attendance at the Solar Union

meeting at Bonn. The next meeting will be in Cleveland during the Holidays, 1912, in connection with the A.A.A.S. The council voted to hold the 1914 summer meeting at Northwestern University, Evanston, Ill., and the 1915 meeting in SanFrancisco and at the Lick Observatory.

Officers were elected as follows:—

President—E. C. Pickering.
First V. P.—G. C. Comstock.
Second V. P.—Frank Schlesinger.
Secretary—Philip Fox.
Treasurer—Miss Annie J. Cannon.
Councillors 1912-1914—W. W. Campbell, E. B. Frost.

The Councillors who continue to serve are

Councillors 1911-1913—W. S. Eichelberger, J. S. Plaskett.

The following is the list of communications presented:—

1. F. Schlesinger. The Orbit of Lambda Tauri.
2. F. Schlesinger. Spectrographic Observations of Algol.
3. F. Schlesinger. Irregularities in Atmospheric Refraction.
4. F. C. Jordan. The Orbit of R Canis Majoris.
5. F. C. Jordan. Spectrographic Observations of Φ Persei.
6. Joel Stebbins. New Eclipsing Variable Stars.
7. E. C. Pickering. Scale of Magnitudes of the Durchmusterungs.
8. R. G. Aitken. Orbits of the Visual and Spectroscopic Binary ε Hydrae AB.
9. S. I. Bailey. Variable Asteroids.
10. L. A. Bauer. On the Cause of the Earth's Magnetism.
11. Miss Annie J. Cannon. The Progress of the Revised Draper Catalogue.
12. C. L. Doolittle. Results of Latitude Observations at the Flower Observatory from December, 1904, to July, 1911.
13. C. L. Doolittle. Constant of Aberration from Observations at the Sayre and Flower Observatories.
14. Philip Fox. A New Form of Collimator.
15. Philip Fox. An Investigation of the 18½-inch Objective of the Dearborn Observatory.
16. Miss Caroline E. Furness. Observations of Variable Stars made at the Vassar College Observatory.
17. W. J. Humphreys. The Daily Variations of the Barometer.
18. W. S. Eichelberger and F. B. Littell. Some Results from the Personal Equation Apparatus of the Nine-Inch Transit Circle of the U. S. Naval Observatory.
19. F. B. Littell. A Screen for Equalizing Star Magnitudes for Transit Circle Work.
20. J. A. Miller and R. W. Marriott. The Twenty-four-inch Objective of the Sproul Telescope.
21. Harlow Shapley. The Orbits of Forty-four Eclipsing Binaries.
22. C. E. St. John. Radial Motion in Sun Spots.
23. C. E. St. John Pressure in the Solar Atmosphere. (Lantern)
24. C. E. St. John and Miss L. M. Ware. The International Standards of Wave Lengths. (Lantern)
25. Frank W. Very. A High-Level Measurement of Solar Radiation.
26. F. W. Very. A Criterion of Accuracy in Measures of Atmospheric Transmission of Solar Radiation.
27. F. W. Very. Sky Radiation and the Isothermal Layer.

28. J. A. Parkhurst. The Relation between Color-Index and Spectrum of Five Hundred Stars. (Lantern)
29. H. N. Russell. On the Graphical Representation of Eclipsing Variables.
30. Frederick Slocum. The Attraction of Sun Spots for Prominences. (Lantern)
31. F. Slocum and S. A. Mitchell. Stellar Parallaxes from Plates Made with the Forty-Inch Refractor of the Yerkes Observatory.
32. R. H Curtiss. The Spectrum of Nova Geminorum No. 2 on March 13, 1912.
33. J. S. Plaskett. A Plane Grating Spectrograph for Stellar Work.
34. J. S. Plaskett. The Solar Rotation.
35. DeLisle Stewart. The Cincinnati Astronomical Society.
36. S. A. Mitchell. Radium in the Solar Chromosphere.
37. E. S. King. Absorption in Space.
38. D. P. Todd and C. J. Hudson. Light Curve of SS Cygni from the Amherst Observations, 1910-12.
39. O. J. Lee. The Spectroscopic System 9 Camelop.
40. G. C. Comstock. Proper Motions of Stars Fainter than the 10th Mag.
41. Arthur Newton. The Solar Eclipse of 1912 as Predicted and Observed.
42. B. Boss. Systematic Motion of the Stars.
43. A. E. Douglass. Evidence of an Eleven Year Cycle in Rainfall.
44. A. E. Douglass. Rotation of Jupiter's First Satellite.
45. F. H. Seares. The Magnitude Scale of the Polar Sequence.
46. F. H. Seares. The Variable RR Draconis.

Professor Campbell sent a written Report from the Committee on Coöperation in the Measurement of Radial Velocities. The response of all the members of the committee was to the effect that, though they might wish to coöperate, their instrumental resources were too weak to attack a long list of stars below the 5.0 visual magnitude where coöperation is desirable, and further that fields of greatest usefulness for them consisted in the study of spectroscopic binaries or special groups of stars. In short, coöperation in the determination of radial velocities of extensive lists of stars fainter than the 5.0 mag. is at present impractical. The report ended with some hopeful suggestions.

The report of the Committee on Asteroids prepared by Professor Ernest W. Brown stated that the principal problems of those interested in the asteroids is to gather data for future discussion, the orbits, the light variations, etc. The first problem is the collection of the observations of position. Some organization to secure more nearly uniform observation of the many asteroids, to care for the new ones, to make certain the securing of a requisite number of early observations, to furnish an early orbit, should be perfected. An international conference on the Asteroid Problem is desirable.

The Committee on Comets reported through its chairman Professor G. C. Comstock that the work of collecting data of photographic observations of Halley's Comet was practically complete. The catalogue is ready for publication. The committee proposes to publish this together with the photographs secured by Mr. Ellerman at Honolulu.

Miss Whiting presented the report of the Committee on Improvement in the Teaching of Elementary Astronomy, giving a resumé of the replies to the circular sent out to observatories, universities and colleges. This circular requested information as to beginning courses, methods of teaching, and suggestion as to methods for improvement. Eighty-two replies were received, state univer-

sities 20, universities and colleges of the first rank 30, and 32 from smaller colleges and schools. Ten report a beginning course of a year, 13 a semester, 42 a short lecture course; 30 require evening observations, 12 some daytime exercises, 10 some work in spectrum analysis, 14 some library work. Only Harvard and Wellesley require two hours of daytime laboratory work and that in addition to the evening work. Concerning the attendance 8 report over 100 in the course, 3 from 70 to 100, 5 from 50 to 70, 65 less than 25. This indicates that a few of our students know anything of matters off this little planet. General interest was expressed in the movement. An observatory for research work should not be the entire equipment of the department. Some replies state the issue in this form: there is an observatory and in the choice between its use for teaching or research, the latter has the stronger claims. Adequate equipment and assistance should be provided for both purposes. The committee called for the assistance of the Society in the effort to make constructive plans.

Professor Schlesinger presented the report of the Committee on Photographic Astronometry. The 10-inch photographic telescope described in the last report has been mounted and put in operation. It is mounted in a constant temperature room having access to the polar region through a window of optically plane parallel glass. Exposures made from without and automatically timed on the chronograph give very exact data for determining the polar point. The methods developed for measuring and reducing the plates were described and some numerical results presented. This work will be continued at least until the Spring of 1913, by which time it is expected that definite knowledge will be secured concerning the movement of the pier mounted in this way.

The financial report showed an indebtedness of about $200. Dr. John A. Brashear announced the purpose of certain Pittsburgh friends of the Society to clear this indebtedness. This generosity was acknowledged in the following resolution:

RESOLUTION

The Astronomical and Astrophysical Society of America assembled at Pittsburgh this 30th day of August, 1912, desires to express to its hosts and friends of Pittsburgh and its vicinity, its appreciation of their kind interest in the Society and their solicitude for its convenience and welfare.

In peculiar measure it acknowledges the generous assistance and entertainment rendered to it by the Trustees of the University of Pittsburgh, more especially those who constitute the Observatory Committee, the Trustees of the Carnegie Institute and the officials of the Homestead Mills of the Carnegie Steel Co.

It is the pleasant duty of the Society also to express appreciation of the unprecedented generosity of its Pittsburgh friends, who through Dr. J. A. Brashear have expressed their purpose of relieving the financial embarassment in which the society is at present involved.

Therefore be it resolved: That this Society extends to all of the above named and to other friends too numerous for individual mention its warmest thanks for their kind interest and assistance.

Publications Received.

Congrès international des éphémérides astronomiques, tenu a l'observatoire de Paris, 23-26 October 1911.

La rotation de la terre, ses preuves mécaniques anciennes et nouvelles, J. G. Hagen, S. J., Specola Astronomica Vaticana I. Appendices, Les preuves de M. Kamerlingh Onnes, J. Stein, S. J.

Calixte III et la comète de Halley, J. Stein, S. J., Specola Astronomica Vaticana II.

Report of the section for the observation of comets (Halley's comet), A. C. D. Crommelin, Memoirs Brit. Astr. Assoc. Vol. XIX, part 1.

The spectrum of Halley's comet in 1910 as observed at Lowell Observatory, V. M. Slipher, Lowell Obs. Bulletin No. 52.

Spectroscopic discovery of the rotation period of Uranus, V. M. Slipher, Lowell Observatory Bulletin No. 53.

Contributions to the mathematical theory of statistics, C. V. L. Charlier, Meddelande från Lunds Astronomiska Observatorium, Nos. 50, 51, 52.

Dynamical theory of the globular clusters and of the clustering power inferred by Herschel from the observed figures of sidereal systems of high order, T. J. J. See, Proc. Amer. Phil. Soc., Vol. LI, No. 204.

Annuaire astronomique pour 1913, Observatoire Royal de Belgique.

Preliminary radial velocities of 212 brighter Class A stars, W. W. Campbell, Lick Observatory Bulletin No. 211.

On the motions of the brighter stars of Class A in relation to the Milky Way, H. C. Plummer, Lick Observatory Bulletin No. 212.

The position of the Mire, Lick Observatory meridian circle, R. H. Tucker, Lick Observatory Bulletin No. 213.

On the real motions of 100 stars of large proper motion, whose radial velocities have been determined, H.C. Wilson, Lick Observatory Bulletin No.214.

Observations of comets and asteroids, C. C. Kiess, Lick Observatory Bulletin No. 215.

Catalogue alphabetique des livres, brochures et cartes, Bibliothèque de l'Observatoire Royale de Belgique, Fascicule II., A. Collard.

Astrographic Catalogue 1900.0, Perth Section, Dec. $-31°$ to $-41°$, Vols. I and IV, W. Ernest Cooke.

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, 1912 June 1.

Publicationen des Astrophysicalischen Observotoriums zu Potsdam, Nos. 64 and 65.

Aktinometrie der Sterne der B.D. bis zur Grosse 7.5 in der Zone $0°$ bis $+20°$ Deklination, K. Schwarzschild, Teil B.

Annals de l'Observatoire Royal de Belgique, Nouvelle série physique du globe, Tome V, Fascicule II.

A catalogue of 2043 stars between $35°$ and $37°$ south declination, from observations made at the Perth Observatory, W. Ernest Cooke.

The Southern Milky Way, by Solon I. Bailey, Annals of the Harvard College Observatory, Vol. 72, No. 3.

Observations of 328 Variable Stars, 1906 to 1910, prepared for publication by Leon Campbell, Annals of Harvard College Observatory Vol. 73, Part 1.

Photographic Observations of Variable Stars, 1886-1905, Annals of Harvard College Observatory Vol. 47, Part 2.

Annaes de Observatorio "Infante D. Luiz," Vol. 48, 1910, Lisbon.

Die Hamburger Sternwarte in Bergedorf (Photographs of buildings and instruments.)

Jahresbericht der Hamburger Sternwarte in Bergedorf, 1910; 1911, Professor Dr. R. Schorr.

Results of Observations made at the Coast and Geodetic Survey Magnetic Observatory at Vieques, Porto Rico, 1909 and 1910, by Daniel L. Hazard, computer Division of Terrestrial Magnetism.

Observações meteorologicas, magneticas e sismicas feitas no Observatorio Meteorologico de Coimbra, 1911, Vol. 50.

Anales del Observatorio de Montserrat, No. 1, Observaciones Meteorológicas de 1911, Simón Sarasola, S. J., Cienfuegos, Cuba.

Greenwich Astronomical Results 1910.

Greenwich Magnetical and Meteorological Observations 1910.

Greenwich Photo-heliographic Results 1910.

Determination of radial velocities of stars at the Royal Observatory, Cape of Good Hope, S. S. Hough, Annals of the Cape Observatory, Vol. 10, Part 1.

On the spectrum and radial velocity of ε Canis Majoris, Joseph Lunt, Annals of the Cape Observatory, Vol. 10, Part 2, Appendix 1.

Undersogelser over egenbevægelserne for 140 stejerner af den IV Secchiske type ved hjælp af ældre og egne observationer, N. E. Nördlund, Publikationer og mindre meddelelser fra Kobenhavns Observatorium No. 9.

Independent day-numbers, 1914, Royal Observatory, Cape of Good Hope.

Studies on Climate and Crops, 3. The "Solar Constant" and the variations of atmospheric temperature at Arequipa and some other stations, by Henryk Arctowski.

TO A COMET.

Hast thou seen Oceanus, Wandering One—
The distant world which circles round the Sun
Beyond the path of Neptune—hast thou seen
The atom-clouds surrounding us between
The Sun's domain and outer darkness?

From whence art thou, O Wandering One—
Hast thou forever known the Sun,
Or art thou of another Star?

Part am I of the atom-clouds,
Those fragments of the first of things
Which once existed in wide rings,
From which the Sun and Planets are.